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Fatigue and performance in VDT related tasks.

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FATIGUE AND PERFORMANCE IN VDT RELATED TASKS

by

SASAN HATAMI

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ABSTRACT

In recent years, as a result of an increasing rate in usage of visual display terminals (VDT) as a mean for processing, inputing, and outputing of information, coupled with increasing reports of eye discomforts, work stress and other complaints from the people who use VDTs, has led to a need for better understanding of man-VDT interaction from the point of view of efficiency and comfort.

Although this need has been realized by many researchers and a substantial volume of international literature has been provided in this area, there appears a dearth of scientific and objective assessment of many aspects of VDTs.

The present study is aimed at enhancing existing knowledge of man-VDT system through studying effects of certain machine and work related factors.

Two sets of experiments were conducted. In the first part of the study character legibility is studied. Character legibility was determined by its generation method, width to height ratio, and image polarity. A paced visual search experiment was undertaken to investigate character legibility by studying discriminability among 5 pairs of capital letters with similar appearances.

Legibility is reported to be significantly lower for some characters formed by dot matrices than those generated by stroke. A 7x7 dot matrix, however, is suggested to be

sufficient for generation of uppercase letters as most of the tested letters were found to be equally legible in both generation methods.

Character width to height ratio may also affect the legibility of characters as it may affect the linearity of inclined segments or smoothness of contours in characters.

Image polarity is not reported to significantly affect discriminability among most characters. However, raster lines in positive image may distort appearace of some letters.

No difference is observed in fatigue as a result of reading from a hard copy display or a VDT screen after 50 minutes. This was also unaffectd by the polarity of the image.

In the second part of the study, effects of time of work and image polarity on visual stress, performance, and fatigue were investigated for 2 hours in an unpaced visual search experiment. Both visual stress and performance were the same for both image polarities. Furthermore, no change in visual performance or stress were obsereved during the two hours of experiment.

The levels of induced fatigue were statistically the same for working with different display images. Similar methodology is suggested for study of visual stress in VDT tasks for longer periods of time in professional VDT operators at work.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

1-1- General Introduction

With the advent of low cost micro and mini computers, Visual Display Teminals (VDT) were introduced into offices. While improvement in productivity has been the major objective in accepting office automation, concern has grown in recent years over many aspects of working with these machines.

Until recently, VDTs were used in computerized systems to enter and display data, primarily by computer operators and programmers. In recent years, however, industries from banking and insurance companies to newspapers and airlines have begun to utilize these machines on a fairly large scale. The use of VDTs has become so widespread that a very conservative estimate in 1980 put the number of VDTs in workplaces across Canada over a quarter of a million units (Black, 1980).

VDTs are now used in offices to improve productivity by performing such time-consuming and repetitive tasks as filing, re-typing, accounting, electronic mail, etc. Many tasks that formerly required special training on the part of the worker are now pooled and can be handled on a terminal with minimum skill requirements.

With the introduction of VDTs in industries and offices a number of problems arose as well. Although these units have not been in mass use for long, their effects are being felt through

complaints from people who use them. An international conference, held in 1979 in Milan concluded that 50% of VDT users report eye strain, 29% headaches, 43% anxiety and depression (Black, 1980; Eisen, 1980).

As a result for the first time, medical experts are taking seriously complaints of eyestrain, headaches, backaches, and irritability from operators who use the machines extensively.

1-2- Character Legibility and Generation Method

Visual work in the form of reading, searching or scanning is by far the most common element of almost all VDT related tasks. Display legibility is, therefore, one of the most important criteria by which the merits of a VDT are judged. Poor legibility can have negative consequences on the ability of the operator to carry out the work. At the simplest level and provided that they are not too frequent, errors are a source of inconvenience and frustration. At a higher level, such as billing, credit checking, etc., the consequence of errors can become more serious and costly.

The legibility of alphanumeric symbols is usually measured in terms of the confusion - or lack of confusion - that occurs in recognizing and discriminating between individual charcters in a display. As a result character sets ability in preserving fine differences in stroke width, curvatue, etc., is particularly important in order to avoid similarities among characters.

Factors which may affect character legibility and thereby affect workers' visual performance and perhaps comfort in VDT tasks are numerous. Among them to name a few, are character luminance, character font, stroke width, contrast and size (Mc Cormick and Sanders, 1982; Snyder and Taylor, 1979; Vartabedian, 1971).

There exists in literature a number of studies pertaining to the study of some of these factors. Snyder and Taylor (1979) concluded that at viewing distances of less than 1.5 meters, character size, dot luminance, and viewing distance have little effect on VDT character recognition accuracy.

Vartabedian (1971) found upright symbols superior to 20 degrees slanted character font.

In studying legibility parameters, such as above, researchers have used tachistoscopic recognition technique in noncontextual forms where symbols are presented briefly (a few milliseconds) and individually.

This technique has the disadvantage that it does not provide the necessary legibility information for related VDT tasks. This is due to the fact that the legibility of alphanumeric characters is affected by the information content of characters when presented in the form of words or character strings, rather than as isolated or unrelated characters (Snyder and Taylor, 1979; Brillouin, 1963).

The significance of symbol legibility, aside from affecting productivity of man-VDT interaction is that the more

difficult it is to discriminate among letters, more stress is likely to be exerted upon users' eyes. Although some degree of visual discomfort and stress is inherent in any task involving extensive visual work, poor legibility of VDT symbols may also become a contributing factor. Character generation method is particularly important as almost all VDTs use dot matrix method instead of conventional stroke method used in printing on paper. The reasons for popularity of dot matrix, over several other commercial methods of generating symbols lies in being both more economical and more versatile (Vartabedian, 1971).

Dot matrix character generation is the technique which is most commonly used for many VDTs using the raster scanning principle. By this method, the required dot positions for each character are stored in a dot matrix memory which is incorporated in the refresh store and coupled to the scanning system of the VDT. Depending upon which character is selected at the keyboard, the required dot information is retrieved from the refresh store and is used to control the brightness of the electron beam. The sequence of dots thus generated builds up the character shape on the VDT screen (Cakir et al., 1980).

Each character is defined by a set of dots from a rectangular matrix of dots as the electron beam scans through its raster pattern. The resolution of the matrix is defined by the number of horizontal and vertical dots which determine the maximum possible horizontal and vertical extends of the character image.

It is generally believed that character definition (or legibility) improves as the density of the dot matrix increases. While there are dot matrices of various resolutions (5x7, 7x7, 7x9, etc), often however, some characters will not have the same appearance that stroke method would provide. This is specially true for those letters which contain contours (such as B or C) or inclined segments (such as X or Y) and are displayed by low resolutions.

1-3- Visual Stress and Discomforts

Almost all VDT related tasks require a significant amount of visual work. Furthermore most of the users' complaints are associated with visual problems.

Visual stress and discomfort are particularly important as they may also contribute to other problems such as postural discomforts. Users trying to compensate for visual problems often assume awkward body positions, resulting in backaches, neckaches and other muscular discomforts.

Significance of such vision related discomforts, aside from affecting worker's efficiency, is that they may also lead to such long-term disabilities as permanent nearsightedness or other health related problems. Dainoff (1981) cites a study conducted by Austrian investigators in which after four hours of continuous work, nine of the fourteen workers showed significant visual acuity changes which were described as myopic or near sightness.

1-4- Fatigue and Critical Fusion Frequency

In assessing fatigue, one of the commonly used methods is the flicker test. The critical fusion frequency, abbreviated as CFF is that rate of successive light flashes from a stationary light source at which the sensation of the flicker disappears and the light appears steady (Simonson and Brozek, 1952).

Fatigue is a broad concept for which there exists no unequivocal definition. Generally speaking, however, fatigue can be considered as a reaction to any form of activity which leads to a reduction of effeciency of the human body and its organs (Cakir, et al., 1980).

CFF tests have been applied in a variety of studies for measurement of fatigue through evaluation of functional deterioration (Henry, 1942; Brozek et al, 1953; Ogata et al, 1977).

1-5- Heart Rate Variability and Mental Load

Heart rate variability, abbreviated as HRV or sinus arrhythmia, in recent years has been used as a measure of mental load.

The heart rate pattern of a normal healthy person at rest is irregular. If one concentrates one's attention on a perceptual task the irregularity of the heart rate pattern tends to diminish as a function of the task difficulty.

In describing perceptual task difficulty, two measures are used. One such measure is the information contents of the stimuli, expressed in units of bits. The other is the number of

signals per unit time that one has to deal with (Edwards, 1964; Sheridan and Ferrell, 1974).

HRV has shown strong correlations with both above measures. As a result it is widely used in many studies as a mean of assessing one's level of concentration in doing a task involving mental activity.

In measuring HRV researchers have used different scoring methods. Opmeer (1973) reported that there are at least 30 different scoring methods used in literature.

Luczak and Laurig (1973) compared 8 different measures of HRV and proposed a scoring method which accounted for both the frequency of changes and amplitude of such changes when heart rate decreases. Both terms, numerator and denominator, as well as the scoring formula itself were reported to be statistically significant on mental load at 5% level of significance (Luczak and Lauring, 1973).

This particular scoring method is adopted for the purpose of this study. The formula for this method of scoring HRV is shown below.

$$HRV = \frac{\sum(HR_i - HR_{i+1}) \text{ for } (HR_i - HR_{i+1}) > 0}{\text{Freq.}(((HR_{i-1} > HR_i) \wedge (HR_i < HR_{i+1})) \vee ((HR_{i-1} < HR_i) \wedge (HR_i > HR_{i+1})))}$$

The numerator is the sum of differences of two successive beats when heart rate is decreasing. The denominator is the frequency of relative maxima and minima.

1-6- Eye Blink Rate as a measure of Visual Stress

From survey of VDT related studies, it appears that in assessing visual stress of operators, researchers have relied solely on the findings of the questionnaires answered by the operators.

There exist methods other than above, for objective evaluation of stress on one's eyes. Eye blink rate is such method which has been used by a number of researchers. Fruhstorfer et al (1977) in studying deterioration in vigilance due to visual stress of train drivers reported a slight increase in blink frequency and a significant increase in blink duration.

Eye blink rate, although more accurate than subjective methods, has not been used very extensively. This is perhaps mainly due to the difficulty in counting the blinks manually. Furthermore, since the blinking pattern may not immediately reflect the changes in independent factors of study, it may require constant monitoring for long times which can become very cumbersome. Simonson and Brozek (1948), in investigating the relation of the level of illumination intensity to stress and fatigue in visual work, monitored the blinking rate manually for 15 minutes each time by means of a stop watch.

In addition, manual monitoring of eye blinks restricts the movements of subjects head and neck which may prove impractical.

1-7- Objectives

Recent work pertaining to the study of VDT-operator interaction has identified certain factors which may cause discomforts (such as glare, reflections from the screen, postural problems, etc.) and researchers have recommended methods to eliminate or reduce effects of such factors.

From the existing literature, however, there appears a dearth of findings with regards to the significance of some important machine related factors as well as an objective assessment of human response in terms of stress and fatigue in working with VDTs.

Character legibility and its effect on visual performance in a contextual form needs to be investigated. It is generally believed that character legibility is inferior on VDTs to that on hard copy displays because of its dot matrix generation method. Image polarity is also an important factor. A positive polarity is recommended by European investigators (Rupp,1981). Significance of this factor in terms of its effcts on visual performance, stress and fatigue, however, has not been studied.

In investigating work stress and fatigue it appears from the literature that conclusions of many studies in this area are based on introspective analysis, in which subjects are asked to subjectively report on their feelings and sensations. Such form of analysis is considered less reliable than was once thought as studies have failed to show a high positive correlation between

such assessments and other measures (Smith, 1979).

An objective assessment of effect of amount of time spent working on a display would be essential in setting proper work-rest scheduals. In this regard, it is hoped that the conclusions of present work will be useful for future studies in this area.

To this end the objectives of the present study are aimed at enhancing the present knowledge of VDT-operator interaction from the point of view of visual performance, stress and fatigue through study of the following:

a)- Visual performance as a function of character legibility.

b)- Visual stress as a function of image polarity and time spent working on the display.

c)- Fatigue as a function of image polarity and type of display.

CHAPTER II

LITERATURE SURVEY

A brief survey of studies pertaining to various aspects of VDTs is provided in the first three sections of this chapter. Section- 4 is devoted to a brief survey of visual related factors, applicable to the objectives of the present work. In the later sections of this chapter heart rate variability and critical fusion frequency and their applications are reviewed.

2-1- Visual Discomfort and Related VDT Factors

Visual discomfort such as eye soreness, irritation, aching, burning, etc. are by far the most frequent complaints VDT users report. After spending several hours at a terminal, operators may experience difficulties in fixating objects. For example, objects may appear to be double images. Furthermore, since VDT characters are relatively blurred and have small area flicker, continuous action of the eye lens may be necessary to achieve proper focus on the characters, and constant adjustment by nerve receptors in the eye to varying light levels (Mourant et al, 1981).

Eye fatigue is caused by tired eye muscles and although it is not considered to be a dangerous problem, it may result in other fatigues or headaches.

Mourant et al (1981) studied the effects of display type on the visual mechanism during a visual search task. VDT usage

of more than 2 hours produced measurable visual fatigue in the eye movement and/or accommodation mechanism, as measured by increased duration to move from a near point and focus on a far point and vice versa. Such visual fatigue was not present in hard-copy visual search task. They also reported an increase in eye blink rate as a result of 4 hours of visual work on VDT screens. Visual fatigue was reduced as a result of breaks.

The relationship between reports of visual, muscular, and psychological complaints of VDT users and performance was examined by Happ and Beaver (1981). They reported a strong association between visual stress and fatigue. It is also concluded that subjects' performance was unaffected despite increases in subject complaints during the task.

Haider,et al., as reported by Dainoff (1981) found that yellow characters had a lower effect on loss of visual acuity of workers than green characters.

Age of worker is a highly significant factor. Older people show a higher sensitivity to glare effect. Additionally, accommodation range (the difference between the far and near points of vision) as well as speed of accommodation decreases. Moreover, the ability of the eye to detect very small differences in luminance also diminishes with age (Cakir, et al., 1980).

Glare is an undesirable effect which may cause visual discomforts and/or visual impairments. This usually occurs when the range of luminances in the visual field is too great (McCormick and Sanders ,1982; Cakir, et al, 1980; Baily, 1982).

In recent years however, glare free VDTs have been made available.

Image polarity has been given considerable attention in Europe where a positive image diplay is recommended; that is, displays with dark symbols on a light background (Rupp, 1981).

Visual acuity and frequency of rest pauses too, have been shown to be very important factors. Workers without proper eyesight are more susceptible to visual discomforts and early fatigue. Dainoff (1981) cites an experiment conducted by Austrian investigators, in which after four hours of continuous work, 9 of 14 workers showed significant visual acuity changes which were described as myopic. After 15 minutes of recovery 3 persons still did not fully recover. The effect of work breaks on visual acuity was also studied. For those operators working for one hour or two hours with an interspread work break, little change in visual acuity was noticed.

Onishi and Kuroe (1982) reported that complaints of VDT operators were related to both their postures and visual loading. The frequency of inserted breaks, four 10 minute breaks and a 60 minute lunch break were reported inadequate to prevent muscle and eye fatigue.

NIOSH researchers have used the Austrian standards as a basis for their recommendation on work breaks. For jobs requiring moderate visual work (less than 50% visual exposure to VDT screen), they suggest a 15 minute break every 2 hours. For people with high vision demands, who look at the screen at least

50-60 percent of the time, a 10-minute break after every 50 minutes of work is recommended (Black, 1980).

2-2- Postural Considerations

In many cases postural discomfort is not unique to VDT workers and in many other jobs which in nature are static (i.e., requiring prolonged sitting) similar discomfort is experienced. In addition, in many VDT tasks visual problems may also contribute to postural discomfort or vice versa; improper postures may lead to visual discomfort. Often workers try to compensate for their poor view of the display by assuming improper sitting conditions. For example posture problems are very common among workers wearing bifocals. Since the bottom part of the bifocal wearers is designed for close vision, they often lean forward while simultaneously bending their necks backward in order to read the screen.

In a study conducted by Smith, et al (1981), a large percentage of workers complained of back pain, pain in arms or legs, stiff neck or shoulders, and other physical pains.

In an investigation of the incidence of postural discomfort among office staff, it was found that 57% of a group comprising 261 male and 117 female employees complained of problems in various parts of the back. 24% of the group complained of problems in the neck and shoulders (Cakir, et al;1980).

Given the fact that most postural problems are due to

improper workplace design, investigators have suggested sitting conditions and workstation designs for VDT tasks; for which the specifications and other details are listed in Appendix-A.

2-3- Visual Factors and Visual Search

In addition to the VDT related studies, there appears in literature a number of other studies that, although were not intended for the study of visual performance on VDTs, their findings and theory however have relevance to the experimental situations of this study.

One such study is that of Drury and Clement (1978), in which the effect of area, density, and number of background characters on visual search time was studied. Each factor was varied independently and the stimulus material was presented in the form of slide projection on a screen. They found that all three variables of area, density, and number of background characters were significant. Search time, however, was reported to be most heavily dependant on the number of background characters.

Influence of type form on reading speed has been studied by Tinker and Paterson (1928). It is reported that the text in lower case letters was read 13.4% faster than that in all capitals. This difference was statistically significant.

Kolers et al (1981) monitored eye movements as subjects read texts presented on VDT screen. They studied the efficiency of reading, which was defined in terms of other factors such as,

total number of fixations, number of fixations per line, rate of fixating, etc. They reported that differences in efficiency of reading single and double-spacing were statistically significant as more densely packed characters required less occular work, and that static pages (non moving) were processed more efficiently than scrolled pages.

Vartebedian (1971) studied the effect of letter size, case, and generation method on VDT-display search time. Subjects searched uppercase letters much faster than lower case, and no difference was observed among three varying sizes or due to different symbol generation methods.

2-4- Critical Fusion Frequency

The fusion frequency of flicker (FFF) or critical fusion frequency (CFF) is that rate of successive light flashes from a stationary light source at which the sensation of flicker disappears and the light appears to be steady (Simonson and Brozek;1952).

The flicker value has been used as an indicator of fatigue in many studies. Simonson & Brozek (1948), studied effect of illumination level on fatigue and found CFF to be sensitive to the stress of visual work and illumination. Simonson and Enzer (1941) have reported that the critical fusion frequency of visual flicker is depressed 10 or 15 percent due to fatigue during the course of a working day. They also concluded that the CFF value is also depressed by insufficient rest.

In another study, however, Brozek et al (1953) concluded that CFF cannot always be used as a sensitive test of fatigue. In their study, they utilized two groups of subjects. The first group consisted of 42 clerical workers and in the second group there were 14 women doing microscopic analysis. The CFF was measured during the first and last half hour of the work day. In both groups, the data for P. M. values were lower than the A. M. values, but the mean differences were very small and in most cases not statistically significant.

Although different people show different levels of sensitivity to the threshold frequency (critical frequency), generally however, older people show lesser sensitivity to the flicker test. This negative correlation between the age of adults and the CFF level has been reported in several independent studies. Simonson and Brozek (1952) observed little change up to about 40 years, with a definite decrement thereafter.

2-5- Heart Rate and Heart Rate Variability (HRV)

The heart rate pattern of a person sitting at rest is irregular. Momentary irregularity of up to ten or fifteen beats per minute can occur (Kalsbeek;1971). In medical literature this phenomenon is generally referred to as sinus arrhythmia.

With the imposition of physical work load or by concentrating one's attention on a perceptual motor task the irregularity of the heart rate pattern tends to disappear as a function of the

load. Imposition of physical or mental load causes an increase in the heart rate and a decrease in its variability from the values found at rest (Kalsbeek, 1971 and 1973; Hitchen et al, 1980).

As a result, analysis of Heart rate variability (HRV) has been suggested as a convenient and useful measure of mental load. The suggestion is further supported by Kalsbeek's (1971) findings that sinus arrhythmia is monotonically related to the level of mental load.

Many workers have studied the relationship between mental load and sinus arrythmia in various experiments and under different conditions. However, more than one method of scoring sinus arrhythmia appears in literature. Opmeer (1973) mentioned that there are at least 30 different methods of scoring sinus arrythmia. Each method of scoring is formulated to emphasise different aspects of variability, such as amplitude or frequency. Luczak (1973) compared eight different formulae of scoring HRV in a binary choice task. Some of the commonly used HRV scoring methods did not show consistent changes in the scored values with the changes in task difficulty.

Mulder et al (1973) reported that in paced choice reaction tasks the number of reversal points (number of relative maxima and minima) in the cardiotachogram is the most sensitive measure of the mental load of the task.

Sayers (1973) conducted a series of experiments involving the effect of mental load on some HRV measures and reported that

the mean heart rate and variance are unreliable measures.

It should be also noted that factors other than mental or physical load may effect heart rate and HRV. For example, it is known that changes occur in heart rate due to respiration. Furthermore, respiration itself has shown to be a function of mental load as well (Rohmert, et al;1973); the respiratory frequency increases with mental load. In particular frequency component of HRV measure is effected by respiratory rhythms. However Hitchen et al (1980) reported that such changes are not significant.

CHAPTER III

THE STUDY

The interaction between man and VDT is studied from the point of view of visual performance ,Visual stress , and fatigue. Two independent sets of experiments were performed. Both experiments were conducted in a relatively quiet room and under a constant ambient illumination level of approximately 420 lux.

3-1- Experiment- I

The objective in this part of the study was to examine character legibility and its effect on human visual performance. Table 3-1 summarises the list of dependent and independent variables.

3-1-1- Experimental Apparatus

Four different displays were used; specifications and description of which are summarised in table 3-1-1.

Measurments of flicker test were performed using an OG - Giken (Model CE-1) digital flicker. This device used a light source of 2.5 mm in diameter with a brightness of 120 cd/m2 on a peripheral background with a brightness of 25 cd/m2.

Independent Variables	Dependent Variables	Purpose
1-Character generation method. 2-Image polarity.	1-Performance	To study visual performance.
1-Type of display (i.e., hard copy display and 3 different VDTs). 2-Image polarity.	1-Fatigue	To compare fatigue on different displays as a result of 50 minutes of paced visual work.

Table 3-1: List of dependent and independent variables of Experiment-I.

Display	Model	Manufacturer	Generation Metod	Approximate width to height ratio	Image Polarity
Hard Copy	-	-	Stroke	1/1	+ve
VDT	VT-52	DEC	7x7 Matrix	2/3	-ve
VDT	TV-910	Tele-Video	7x7 Matrix	1/2	+ve
VDT	TV-910		7x7 Matrix	1/2	-ve

Table 3-1-1: Specifications (in terms of independent variables of study) of displays used in the study.

3-1-2- Experimental Protocol

10 male university students whose first language was English, in the age group of 22-28 and with no apparent physical handicap participated in these experiments. As an incentive they were paid a variable amount of $6.00 - 8.00 per hour depending on their performance. They were required to search for errors in a paced visual search task. The text was in upper case and consisted of 48 pages; each page containing 20 lines. A sample page of the text (reduced to 9/16 of its actual size) is shown in figure 3-1-1.

Subjects had 45 seconds for each page. The objective in allowing a limited time was to simulate a systematic proof-reading condition (i.e., a reading or reading- scanning visual inspection strategy) rather than a random search. Therefore the time had to be long enough, on one hand, for subjects to detect errors and short enough on the other to force them to adopt a reading-searching strategy where errors could be detected on the basis of recognition of words in which errors were embedded rather than close inspection of every character.

Two factors were taken into account in deciding upon 45 seconds as the allowed time for processing each page. First, a reading speed of approximately 320 words per minute obtained by Lang (1969) in reading a lower case material was adopted as average reading speed for the purpose of the study. The text used in the experiments contained ,on an average, approximately 190-205 words per page. Second, since the text was presented in

100,000 CANADIANS SPENDING MOST OF THEIR WORKING DAYS IN FRONT OF THESE MACHINES, ENTERING BANK WITHDRAWALS, FILLING PLANE RESERUATIONS , ROUTING LONG DISTANCE CALLS, OR EDITTING NEWSPAPER ARTICLES. WITH SVCH A HIGH RATE OF HUMAN EXPOSURE TO THESE T.V. SCREEN LIKE AND KEYBOARD COMBINATION, WHICH HAVE BECOME VERY POPULAR IN ANY PLACE WHERE FAST AND CONVENIENT INFORMATION ENTERING AND ACCESS IS DESIRED, QUESTIONS ARE FINALLY BEING ASKED ABOVT WHAT VDTS ARE DOING TO OFFICES AND THE PEOPLE WHO WORK WITH THEM. ALTHOUGH A VISUAL DISPLAY TERMINAL IS A VERY SMALL PART OF THE TOTAL SYSTEM, BUT IT IS A VITALLY IMPORTANT PART SINCE IT FORMS THE MAN-COMPUTER INTERFACE. PERHAPS THE PRESENT EMPHESIS BEING PLACED ON IMPROVING PRODUCTIVITY IS ONE REASON FOR SYSTEMS TO BECOME MORE COMPLEX AND CAPABLE OF OPERATING AT HIGHER SPEEDS, WHICH IN TURN MAKES THE MAN'S DECISION TIME SHORTER AND THERFORE THE OPERATOR PACED PART OF THE TASK BECOMES THE GATING ITEM. WITH THE INTRODVCTION OF VDTS IN INDUSTRY AND OFFICES A NUMBER OF PROBLEMS AROSE AS WELL. ALTHOUGH THESE UNITS HAVE NOT BEEN IN MASS USE FOR LONG, BUT HOWEVER ITS EFFECTS

Figure 3-1-1: A Sample Page of Text.

upper case letters more time was allowed as lower case texts are read faster (as much as 13.4%) than that in all capitals (Tinker and Paterson, 1928).

Timing in case of hard copy display was done manually using a digital stop watch and in the case of VDTs (the other three displays) a PDP 11 computer (manufactured by DEC) was used in displaying and timing each page.

Subjects had no prior knowledge of the type of error they would encounter but they were told that only one of the six types of errors, presented in table 3-1-2, could appear in any one page at a time; they were required to record the type of error and number of times it was found in that page on the sheets provided.

Each pair was presented in eight different pages and thus provided seven replications for each type of error. The first five pairs were used in discriminability study of like characters. These were chosen on the basis of similarity of their appearances and are shown in figure 3-1-2 as they appeared on the displays used. The last one, named CR (Character Repeated) errors were simple repetition of one of the characters of any word whose correct spelling would be known to subjects.

(CR) errors were included for two reasons: a- to determine the search strategy adopted by subjects. It is evident that if the material is to be read, repetition of one of the characters would be easily detectable as its appearance would be unfamiliar to the reader's eyes. If the material, on

Type of Error	Example
I - 1	TIME
K - X	EKAMPLE
S - 5	WA5
D - O	HDUR
U - V	MANVAL
CR	AAND

Table 3-1-2: Character Pairs Used as Errors in Study of Discriminability.

I - l

S - 5

K - X

D - O

U - V

Figure 3-1-2 (a): Character Pairs on Hard Copy Display.

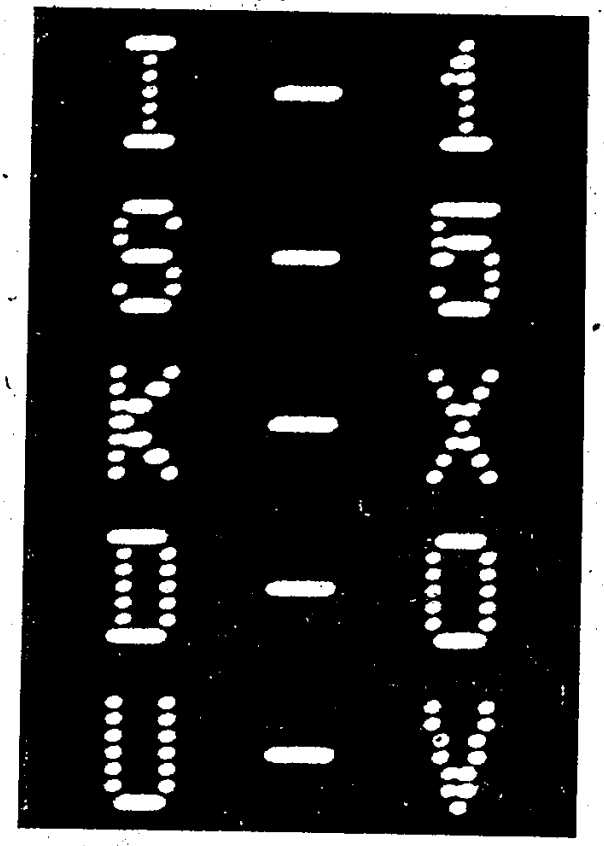

Figure 3-1-2 (b): Character Pairs on VT-52 VDT.

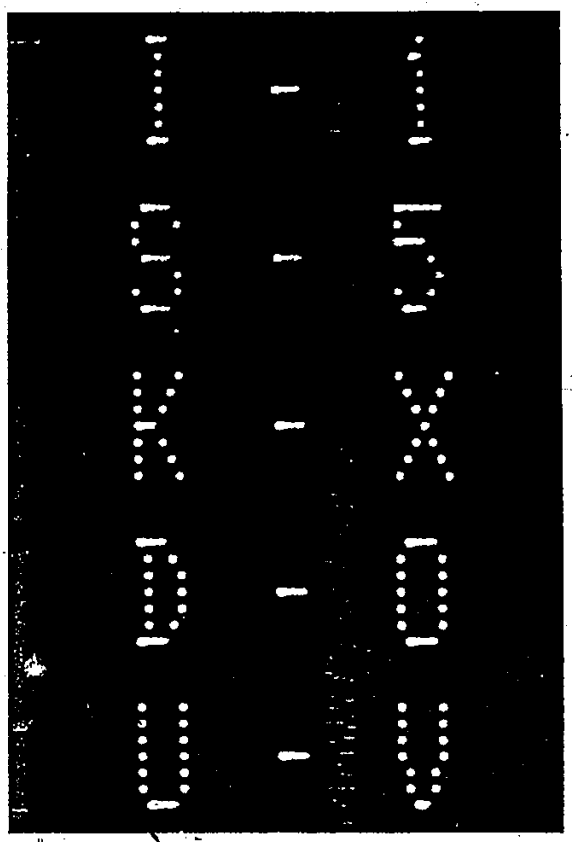

Figure 3-1-2 (c): Character Pairs on TV-910 VDT.
(Negative Polarity)

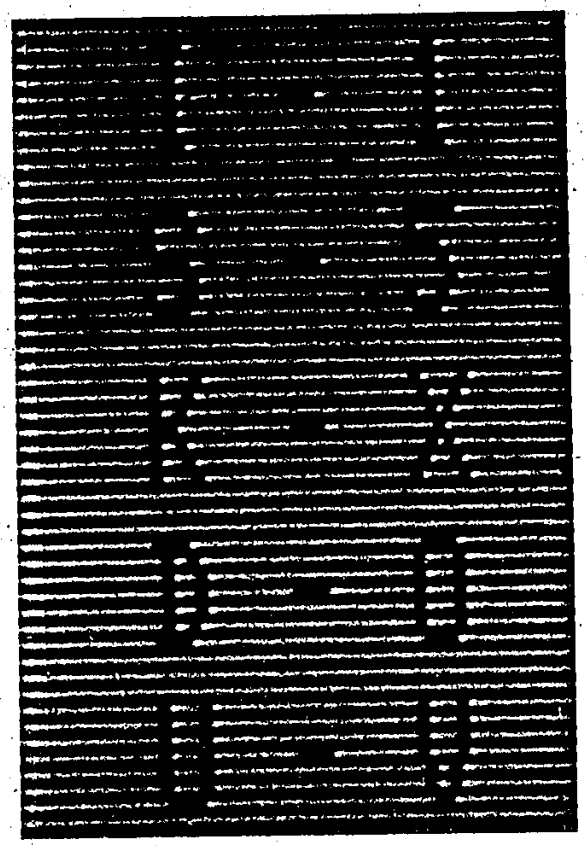

Figure 3-1-2 (d): Character Pairs on TV-910 VDT.
(Positive Polarity)

the other hand, is to be scanned in search of any of the other types of error, (CR) errors may not be so easily identifiable. (b)- Since factors other than character legibility such as inter-character and inter-line spacings may also have some effect on performance, (CR) errors could point out possible differences in performance due to above factors as detection of (CR) errors was independent of their visual appearance or legibility.

Each experimental session lasted for approximately 50 minutes. A 5 minute practice session preceded each session so that subjects could adjust their speed within the limited time allowed for each page.

To provide an assessment of fatigue as a result of 50 minutes of paced visual search, flicker tests were performed before and after each session. Six values were obtained before the commencement and after the conclusion of each experimental condition by using an ascendant mode; i.e., the flicker frequency of the light source is increased continuously from very low frequency to very high, until the subject cannot observe its flickering and begins to feel it as a continuous lighting.

3-2- Experiment- II

Independent factors of this part of the study were image polarity and work duration. Dependent variables were visual stress as indicated by subjects' blink rate, and performance as

measured in terms of percent errors detected in an unpaced visual search task.

3-2-1- Experimental Apparatus

A Tele-Video VDT (model TV-910) was used to provide both positive and negative image polarities of the display. This unit was connected to an IBM-3031 computer through WYLBUR where the text used in experiments resided. The unit was placed on an adjustable table. The surface of this table could be tilted, or moved vertically. There was enough clearance for the subjects' feet and knees. The chair that subjects sat on was also adjustable and provided arm rests which could be adjusted in any direction to the most comfortable posture for each individual. Figure 3-2-1 shows a subject during an experimental session.

Measurements of the Critical Fusion Frequency (CFF) values for assessing the resultant fatigue were conducted using the digital flicker instrument whose description has been provided in an earlier section.

Subjects' momentary heart rate was monitored by a polygraph pre-amplifier, along with an ECG tachograph pre-amplifier (GRASS Instruments, model 7). Floating skin electrodes, manufactured by Beckman, were placed on the subject's chest using adhesive tape. Figure 3-2-2 illustrates the position of electrodes on subject's chest.

Eye lid movements were monitored with an eye movement monitor (Model 200), manufactured by Applied Science

Figure 3-2-1: Subject and Experimental Setup.

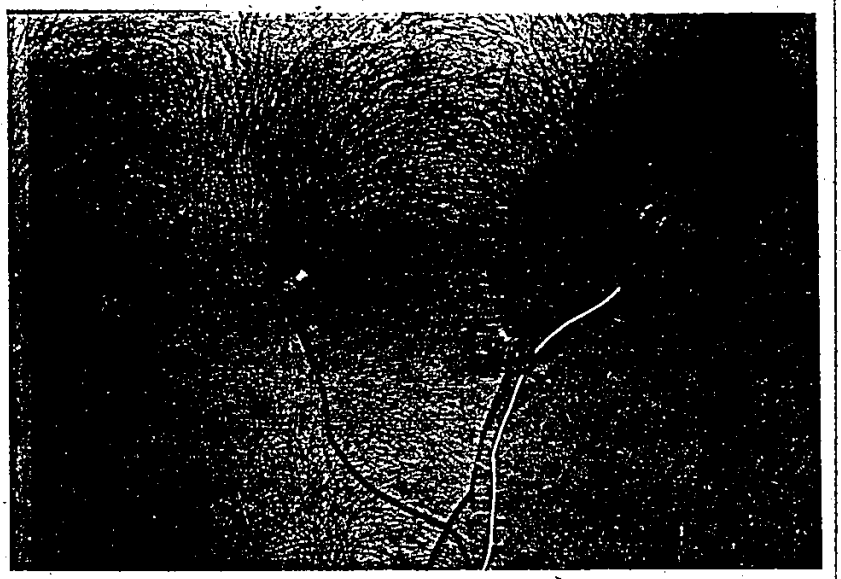

Figure 3-2-2: Position of Electrodes on Skin.

Laboratories to count the number of blinks.

The eye movement monitor employs a photoelectric sensing and processing technique to determine magnitude and direction of eye movements. Eye movements are sensed by a pair of silicon phototransistors operating in conjuction with a gallium arsenide infrared source mounted in front of each eye, just below or above the eye lid. The device does not require attachments to the eye or skin and does not significantly interfere with the subject's head movements or vision.

This device consists of a transducer spectacles as well as the eye movement monitor itself which amplifies the current produced as a result of an eye movement. For sensing the blinks, only the vertical channel was used to monitor the upper lid of either eye. Figure 3-2-3 shows the eye movement monitor's spectacles as mounted on the subject.

Three independent computer programs, named HRV0, HRV1, and HRV2 were developed for monitoring subjects' momentary heart rate and blink rate. The first program, HRV0 is used for calibration of ECG-PDP interface. The program samples the ECG device 50 times, 4 times a second and displays three scaling parameters which are used by program HRV2 for calculation of heart rate variability values.

The second program (HRV1) is used for actual data collection during the experiment. The program samples the analog output of ECG device and eye movement monitor 6 times a

Figure 3-2-3: Eye Movement Monitor's Spectacles Mounted on Subject.

second; converts them to coded values through an analog to digital converter (ADC); and then transfers the coded values directly onto a magnetic disk. The program is initially interactive; it first asks the user to input subject's initials (e.g., PGR) and then a condition number corresponding to a particular experimental condition (e.g., 06).

Once the user has specified above information it then waits for the user's command to start collecting data. Following the command the program starts to collect data for 15 minutes and stops and waits for 15 minutes. This sequence is repeated 4 times during the experiment. Finally, it will create a file whose name and specifications are those specified by the user (e.g., file PGR06).

The third program is used for interpretation of the collected data and the user is required to input the scaling values from program HRV0, and corresponding file specifications. This program consists of two separate parts, one for calculation of heart rate variability indices and the other for counting the number of blinks for each 15 minutes of data collection. The output of this program consists of the following information for every 15 minutes of data collection:

1- Number of decreasing points in heart rate.

2- Number of increasing points in heart rate.

3- Sum of heart rates when decreasing.

4- Number of the relative maximia.

5- Number of the relative minima.

6- Heart rate variability score as determined by division of score in (3) by the summation of scores in (4) and (5).

7- Cumulative number of blinks.

Coded values corresponding to ECG's output are first converted to heart rates using conversion factors of HRVO. Each heart rate value is then compared to the previous one and if the magnitude of the difference is greater than 0.50 a change in heart rate is recorded. The value 0.50 was found experimentally, and on the basis of several trials to yield the most accurate results as the signal provided by ECG anolog output is not noise free.

For counting the number of blinks, however, no conversion is made from coded values and relative changes in these values are directly used in the interpretation of data. In order to count the blinks, the program checks for sudden rise or declines in coded values. If these changes are followed by changes of more than 5% in magnitude and in the opposite direction of the original change and within a time period of less than or equal to 0.5 seconds then it is considered as a blink. Otherwise sudden changes by themselves or followed by very small changes

are considered as an eye movement rather than a blink.

The assumption in above logic is that subject's blinking duration in closing his eye should be less than or equal to 0.5 seconds. This condition is necessary as the program should distinguish between eye movements and blinks. Although seccades (eye movements) by themselves are extremely fast, they must be followed by eye fixations whose duration on the average is approximately 300 milliseconds (Lang,1969; Karger and Bayha,1977). Thus if two sudden saccades are made, one immediately following the other, and in the opposite directions of each other, they will last for more than 0.5 seconds and hence will not be considered as blinks.

Accuracy of both parts of this program have been tested by monitoring heart rates and eye blinks of two subjects, each for 12 minutes. Heart rate variability results are almost identical to those found from polygraph's charts. More specifically, it appears that on average the program that samples the ECG (i.e., HRV1) misses one heart beat per minute. As for the accuracy of the counted number of blinks, it is sensetive to the proper calibration of the eye movement monitor and the positioning of the spectacles. For a proper setting of above two, however, the counted number of blinks deviate, on average, by approximately 5% from the actual blinks counted by the experimenter. These programs are listed in Appendix-B.

To provide an assessment of general fatigue as a result of 2 hours of paced work, CFF tests were performed using an

ascendant mode.

3-2-2- Experimental Protocol

10 male subjects participated in these experiments. Independent variables of study were work duration and image polarity. Subjects searched for errors in a text (presented in lower case) at their own pace. The text was presented to them on a TV-910 VDT screen in segments (or pages) of 20 lines each. Upon completing a page they would proceed to the next segment by simply pressing the RETURN key on the VDT's keyboard.

Two types of errors were embeded in the text: either one character was missing or a character was repeated in any word. These errors were placed randomly in different pages and in different words. They were, however, placed in such words whose spelling would be familiar to subjects and thus not hamper their performance as a result of possible differences among subjects in their spelling abilities. Detection of these errors, however, required considerable amount of visual work as the text had to be inspected carefully to detect errors (as was also shown by results of earlier experiments of experiment- I, in which CR errors, comparatively, were not easily detectable by simply scanning the text).

It was suspected that errors involving absence of a character of a word could possibly be more difficult than character repetition type error. This, coupled with the fact that subject's performance needed to be monitored as a function

of time, made it necessary to have a consistent level of task difficulty, over each period of time. To this end, an equal number of each type of error was placed in every 100 lines of text.

Each subject worked on both image polarities each time for two continuous hours, during which no breaks were given. They were required to record the line number in which they found an error, and the error itself. Performance was defined as the percentage of errors detected.

During the experiment subjects' performance was recorded at the end of every consecutive 30 minute period by recording a mark on their performance sheet.

It was anticipated that subjects' performance may deteriorate over time due to factors other than fatigue. Although subjects were rewarded with monetary incentives proportional to their performance, it was suspected that they might find the 2 hours of experiment monotonous and boring. To this end variability in their heart rates was used as an indicator of their level of concentration or mental load during each 30 minute period. Cumulative number of blinks were monitored to provid an assessment of subjects' visual stress and discomforts.

CHAPTER IV

ANALYSIS, RESULTS AND DISCUSSION

In statistical analysis of all data in this chapter, a 5% level of significance is used.

4-1- Results of Experiment-I

Results of the first part of the study are reported in two sections: 1- Results of character legibility as indicated by subjects' performance; and 2- Results of CFF tests as a measure of induced fatigue.

4-1-1- Character Legibility

Obtained data were analysed according to a mixed-nested factorial experimental design with subjects (SUB) effect treated as random and type of error (BCD) nested in displays (DISPLAY). Type of error was treated as a nested effect since levels of (BCD) do not cross those of display effect since generation of characters was unique for each display type.

Table 4-1-1 shows the results of ANOVA for the dependent variable performance. All main effects and their interactions were significant. Significance of the factor (SUB) points out differences among subjects in their overall performance in detecting errors. Significance of the factor (DISPLAY) means that there were significant differences among the four displays

Source	df	SS	F value	Finding
SUB	9	2.600	3.34	Sig.
DISPLAY	3	2.996	4.31	Sig.
SUB*DISPLAY	27	6.253	2.67	Sig.
BCD(DISPLAY)	20	42.329	19.20	Sig.
SUB*BCD(DISPLAY)	180	19.846	1.27	Sig.
ERROR	1680	145.549		

Table 4-1-1: ANOVA for results of performance evaluation.

in terms of their overall legibility. Similarly, it can be inferred from significance of factor (BCD) that types of errors used in the experiment were not of the same level of difficulty (i.e., it was easier to discriminate between certain character pairs than others). Further interpretation of these effects as well as their interactions is provided in later parts of this section.

Duncan's multiple range test was performed and statistical ranking of displays in terms of overall legibility (based on the 6 types of errors tested) of their characters is shown in table 4-1-2.

The ranking of displays shown in table 4-1-2 is based on performance in detecting errors. It can therefore be inferred that overall legibility of the first three displays were statistically the same, while the last one (i.e., VDT4) showed a significantly poorer legibility. This is discussed later in this chapter in the discussion of image polarity.

Subjects' performahces were analysed further for each display and the resultant ANOVA tables are summarised in table 4-1-3. Here, subjects' effect shows significance only when working on VDTs (tables 4-1-3 b,c,and d), while no significant difference was found among subjects in their performance on the hard copy display (table 4-1-3a). This may be attributed to differences among subjects in their previous experience in reading from VDT screens. It may, therefore, be suggested that people who are less familiar with reading from VDT screens may

Mean (%)	Display	Grouping
76.04	PAPER	A
74.81	VDT2	A
72.23	VDT3	A
65.81	VDT4	B

Table 4-1-2: Statistical rankings of displays for their overall legibility. Means with the same letter are not statistically different at 5% level of significance.

Legend:
VDT2: VT-52 VDT, with negative polarity.
VDT3: TV-910 VDT, with negative polarity.
VDT4: TV-910 VDT, with positive polarity.

Source	df	SS	F value	Finding
SUB	9	0.526	0.79	-
BCD	5	14.592	22.64	Sig.
SUB*BCD	45	5.800	1.73	Sig.

Table 4-1-3a

Source	df	SS	F value	Finding
SUB	9	1.867	2.38	Sig.
BCD	5	5.093	11.70	Sig.
SUB*BCD	45	3.916	1.00	-

Table 4-1-3b

Source	df	SS	F value	Finding
SUB	9	3.323	4.29	Sig.
BCD	5	7.228	11.95	Sig.
SUB*BCD	45	5.444	1.41	Sig.

Table 4-1-3c

Source	df	SS	F value	Finding
SUB	9	3.138	3.52	Sig.
BCD	5	15.417	29.62	Sig.
SUB*BCD	45	4.685	1.05	-

Table 4-1-3d

Table 4-1-3: ANOVA for performance on:

a)- Hard copy display.
b)- VT-52 VDT.
c)- TV-910 VDT with negative polarity.
d)- TV-910 VDT with positive polarity.

be more vulnerable to making mistakes in discrimination of like characters, when working on VDT screens.

Duncan's multiple range test is performed for each display and results are shown in order of discriminability of each character pair in table 4-1-4. From results of the statistical ranking of the character pairs two conclusions may be drawn.

First, the order of discriminability of character pairs is not the same on all displays and thus suggest significant legibility differences among the four displays. For example the legibility of characters (I) and (l) was very poor on the hard copy display while subjects found it relatively easier (with respect to other types of error) to discriminate between (I) and (l) on VT-52 display.

Second, the relative position of (CR) errors in above rankings shows that the objectives of the experiment in simulating proof reading situations is achieved as detection of CR errors is not the easiest and thus suggest a reading-scanning visual search strategy.

Analysis of variance was performed for each type of error and results are shown in table 4-1-5. Displays varied significantly from one another in the case of I-l, S-5, U-V, and D-O type errors while no significant differences were found among displays in case of K-X and CR errors.

Duncan's multiple range test, presented in table 4-1-6 shows how the four displays varied from one another in terms of legibility of the tested characters. With the exception of I-l

BCD	Mean (%)	Grouping
S-5	93.76	A
K-X	89.43	A
CR	77.96	B
U-V	77.82	B
D-O	77.58	B
I-1	39.69	C

Table 4-1-4a.

BCD	Mean (%)	Grouping
K-X	87.49	A
S-5	83.66	A B
CR	76.50	C B
I-1	73.46	C
U-V	72.61	C
D-O	55.11	D

Table 4-1-4b.

BCD	Mean (%)	Grouping
K-X	91.89	A
S-5	84.30	A
CR	73.38	B
D-O	63.58	C
I-I	61.08	C
U-V	59.16	C

Table 4-1-4c.

BCD	Mean (%)	Grouping
K-X	90.81	A
CR	78.55	B
S-5	75.34	B
U-V	60.43	C
D-O	53.28	C
I-1	36.44	D

Table 4-1-4d.

Table 4-1-4: Statistical rankings of discriminability among character pairs for:
a)- Hard copy display.
b)- VT-52 VDT.
c)- TV-910 VDT with negative polarity.
d)- TV-910 VDT with positive polarity.

Means with the same letter are not statistically different at 5% level of significance.

Source	df	SS	F value	Finding
SUB	9	5.230	4.64	Sig.
DISPLAY	3	7.480	12.99	Sig.
SUB*DISPLAY	27	5.182	1.53	Sig.
ERROR	280	35.066		

Table 4-1-5a.

Source	df	SS	F value	Finding
SUB	9	0.960	1.98	Sig.
DISPLAY	3	1.362	5.48	Sig.
SUB*DISPLAY	27	2.238	1.54	Sig.
ERROR	280	15.057		

Table 4-1-5b.

Source	df	SS	F value	Finding
SUB	9	0.789	2.08	Sig.
DISPLAY	3	0.087	0.48	-
SUB*DISPLAY	27	1.612	1.41	-
ERROR	280	11.817		

Table 4-1-5c.

Source	df	SS	F value	Finding
SUB	9	1.718	1.62	-
DISPLAY	3	2.019	4.31	Sig.
SUB*DISPLAY	27	4.217	1.32	-
ERROR	280	33.029		

Table 4-1-5d.

Source	df	SS	F value	Finding
SUB	9	1.495	1.44	-
DISPLAY	3	2.944	11.75	Sig.
SUB*DISPLAY	27	2.256	0.73	-
ERROR	280	32.229		

Table 4-1-5e.

Source	df	SS	F value	Finding
SUB	9	1.239	2.10	Sig.
DISPLAY	3	0.129	0.65	-
SUB*DISPLAY	27	1.763	1.00	-
ERROR	280	18.351		

Table 4-1-5f.

Table 4-1-5: ANOVA for individual types of errors: a)- I-1; b)- S-5; c)- K-X; d)- U-V; e)- D-O; f)- CR.

Display	Mean (%)	Grouping
VDT2	73.46	A
VDT3	61.08	B
PAPER	39.69	C
VDT4	36.44	C

Table 4-1-6 (a)

Display	Mean (%)	Grouping
PAPER	93.76	A
VDT3	84.30	B
VDT2	83.66	B
VDT4	75.34	C

Table 4-1-6 (b)

Display	Mean (%)	Grouping
VDT3	91.89	A
VDT4	90.81	A
PAPER	89.42	A
VDT2	87.49	A

Table 4-1-6 (c)

Display	Mean (%)	Grouping
PAPER	77.83	A
VDT2	72.61	A
VDT4	60.43	B
VDT3	59.16	B

Table 4-1-6 (d)

Display	Mean (%)	Grouping
PAPER	77.58	A
VDT3	63.58	B
VDT2	55.11	B
VDT4	53.28	B

Table 4-1-6 (e)

Display	Mean (%)	Grouping
VDT4	78.55	A
PAPER	77.96	A
VDT2	76.50	A
VDT3	73.38	A

Table 4-1-6 (f)

Table 4-1-6: Statistical rankings of displays for each character pair of: a) I & 1, b) S & 5, c) K & X, d) U & V, e) D & O, and f) CR.

Means with the same letter are not statistically different at 5% level of significance.

Legend:
- PAPER: Hard copy display.
- VDT2: VT-52 VDT, with negative polarity.
- VDT3: TV-910 VDT, with negative polarity.
- VDT4: TV-910 VDT, with positive polarity.

character pair all other character pairs were, statistically, either more discriminable or equally discriminable from one another on the hard copy display.

Performance in detecting (CR) errors is shown to be the same on all four displays. This therefore suggests that factors other than character legibility (such as inter-character and inter-line spacings) had insignificant effects on subjects' performance and thus any variations in subjects' performance in detection of errors and on different displays is merely due to the legibility of their characters.

Furthermore, as seen from table 4-1-6, comparison of the two different polarities of TV-910 VDT display (i.e., VDT3 and VDT4), indicates a significant difference between the two displays in case of two character pairs. These two displays differed from one another only by the polarity of their images. Specifically, discriminability between I and l, and S and 5 were significantly poorer when working on the positive polarity of the display.

Close inspection of pictures of displays, (Figures 3-1-2c & d) reveals how raster lines may have distorted the appearance of these characters. Raster scanning is a method of scanning display in horizontal lines and is used for television and many VDT displays (Grover, 1976).

Presence of raster lines may degrade the overall definition of a character by distorting appearances of some dot positions in the dot matrix. This is specially true for such

letters whose appearances are very similar to some other ones and differ from one another on the basis of only a few dots (e.g., I & l). Moreover, in such displays one has to read or search from a display that is not uniform in background luminance. As a result raster lines may even produce visual illusions and hence characters which may be clearly defined and distinguishable in normal displays (i.e., with uniform background) may be mistaken for others due to distortion of their images by raster lines.

Comparison of results for the two displays of VT-52 and TV-910 (both with negative polarity) VDTs shows that there was a significant difference between the two displays in the legibility of their characters in the case of I-l and U-V type errors.

These displays, both had a negative image polarity and employed a 7x7 dot matrix. They differed, however, from one another in their character width to height ratio. This suggests that character width to height ratio, also, may affect the legibility of characters. No general conclusion can, however, be drawn as neither display showed to be superior to the other in both above character pairs. It appears that the effects that character width to height ratio may have on legibility of characters depends itself on characters' appearance and shape. As a result , for example, a higher character width to height ratio may improve legibility of certain characters while degrading definition of some others in the same alphanumeric

character set.

4-1-2- Fatigue

Results of flicker tests were analysed according to a mixed factorial experimental design, with subject's effect treated as random. Table 4-1-7 displays ANOVA results.

Subjects showed significant differences in their CFF readings (table 4-1-7). This is normal as individuals have varying levels of sensitivity to flicker frequency (Simonson and Brozek, 1952). Interaction of subjects by the other two main effects of condition (COND) (i.e., before or after experimental values) and type of display (DISPLAY) as well as the three way interaction were significant. These imply that certain subjects found the task (SUB*COND), or certain display(s) (SUB*DISPLAY), or both (SUB*DISPLAY*COND) more fatigueing than average. These are further explained later in discussion of results for individual displays as well as in discussion of results of CFF tests in experiment-II.

Effects due to factor (COND) were found to be highly significant and thus imply measurable levels of fatigue as a result of 50 minutes of paced visual work. Levels of fatigue however, for each display were the same for all displays as the contribution of factor (DISPLAY) is insignificant. This therefore suggests that VDT usage may not be necessarily more fatigueing, as generally presumed by users or researchers, than conventional paper material usage for the same level of

Source	df	SS	F value	Finding
SUB	9	3315.858	213.54	Sig.
COND	1	77.602	14.56	Sig.
SUB*COND	9	47.963	3.09	Sig.
DISPLAY	3	26.442	1.01	-
SUB*DISPLAY	27	235.554	5.06	Sig.
COND*DISPLAY	3	4.853	0.94	-
SUB*DISPLAY*COND	27	151.801	3.26	Sig.
ERROR	400	690.127		

Table 4-1-7: ANOVA for analysis of CFF readings.

involving work.

Percent change in mean CFF values, for all displays, and from pre to post experiment was approximately % 2.26.

Separate analysis was performed for each display and ANOVA tables are shown in table 4-1-8. Here, further explanation for significance of interaction terms involving subjects is provided. Variable (COND) is significant for all displays. Effects due to variations among subjects, too, is significant in all cases. Interaction term of (SUB*COND) however, is significant in the case of those two displays with negative polarity (i.e., TV2 and TV3 VDTs).

From the above, it can be inferred that some may find either polarity more tiring. This interaction is also reported as significant in analysis of CFF results of Experiment-II and further explanation is provided in the corresponding section.

4-2- Results of Experiment- II

Results of this part of study are reported in three sections, viz., Analysis of : 1- Performance, 2- Visual stress, and 3- Fatigue.

4-2-1- Analysis of Performance

To study fatigue and its effect on visual performance, as measured by performance degradation, a regression analysis was carried out. The effects of time and level of concentration on performance degradation are examined through time and heart rate

Source	df	SS	F value	Finding
SUB	9	937.738	62.38	Sig.
COND	1	10.920	6.20	Sig.
SUB*COND	9	15.851	1.05	-
ERROR	100	167.037		

Table 4-1-8a

Source	df	SS	F value	Finding
SUB	9	728.431	54.53	Sig.
COND	1	38.760	3.55	Sig.
SUB*COND	9	98.235	7.35	Sig.
ERROR	100	148.433		

Table 4-1-8b

Source	df	SS	F value	Finding
SUB	9	954.828	44.99	Sig.
COND	1	14.911	1.85	-
SUB*COND	9	72.725	3.43	Sig.
ERROR	100	235.812		

Table 4-1-8c

Source	df	SS	F value	Finding
SUB	9	930.413	74.46	Sig.
COND	1	17.864	12.41	Sig.
SUB*COND	9	12.953	1.04	-
ERROR	100	138.845		

Table 4-1-8d

Table 4-1-8: ANOVA for results of CFF on individual displays:

a)- Hard copy display.
b)- VT-52 VDT.
c)- TV-910 VDT with negative polarity.
d)- TV-910 VDT with positive polarity.

variability (HRV) scores. The HRV score was derived by dividing the sum of heart rate variabilities when heart rate decreases, by the total number of relative maxima and minima. In addition the first order interaction of the two main effects (TIME*HRV) is also tested. ANOVA for this analysis is shown in table 4-2-1. Both main factors as ~~well~~ as their interaction showed insignificant effects on the dependent variable and thus suggest no significant deterioration in performance due to fatigue.

Effect of image polarity (DISPLAY) on visual performance was found to be statistically insignificant as shown in table 4-2-2. This also confirms results of the first experiment where no significant difference was reported in detection of (CR) errors as a result of difference of image polarity. Subjects' performance, on the other hand varied from one another significantly. The two way interaction of (SUB*DISPLAY) is also reported significant. This implies that some subjects performed comparatively better on either display. This may be due to the fact that some subjects had some previous experience in working with negative polarity of VDTs.

4-2-2- Analysis of Visual Stress

Visual stress as indicated by subjects' blink rate (i.e., number of blinks per minute) was examined as a function of image polarity (table 4-2-3). Image polarity's effect was found to be insignificant on blinking pattern. Subjects' effect as well as its interaction with image polarity (SUB*DISPLAY) were found

Source	df	SS	F value	Finding
HRV	1	66.173	0.85	-
TIME	1	103.826	1.33	-
HRV*TIME	1	4.258	0.05	-
ERROR	72	5615.341		

Table 4-2-1: ANOVA for results of performance as a function of time.

Source	df	SS	F value	Finding
DISPLAY	1	2.738	0.02	-
SUB	9	1942.947	3.65	Sig.
SUB*DISPLAY	9	1534.635	2.88	Sig.
ERROR	60	3552.940		

Table 4-2-2: ANOVA for results of performance as a function of image polarity.

Source	df	SS	F value	Finding
DISPLAY	1	4.803	0.65	-
SUB	8	330.756	29.27	Sig.
SUB*DISPLAY	7	51.559	5.21	Sig.
ERROR	51	72.042		

Table 4-2-3: ANOVA for analysis of visual stress as a function of image polarity.

significant. The former simply implies a difference among subjects in their blinking pattern, while the latter suggests that some subjects found either image polarity more stressfull on their vision.

The pooled data for both image polarities was then analysed to investigate the time effect on visual stress. The ANOVA is presented in table 4-2-4. It is concluded that no significant changes occured in blinking pattern of subjects during the 2 hours of visual work. This is shown by (TIME) factor, as it is found to have insignificant effect on the dependent variable of blink rate.

4-2-3- Analysis of Fatigue

Results of flicker tests were analysed according to a mixed factorial experimental design with subjects effect treated as random. Subjects, on average, showed a 3.6% decline in their CFF values from before to after experiment. This difference was statistically significant, as shown by the factor (COND) in table 4-2-5. The other main effect, image poarity (DISPLAY) was found to be insignificant. Subjects (SUB) varied significantly from one another in their CFF values.

It can therefore be concluded from above that the two image polarities had equal contributions in induced fatigue. This was not however, the case for all subjects as the two way interactions of subjects with the other two main effects (i.e., DISPLAY and COND) also showed significance.

Source	df	SS	F value	Finding
TIME	3	3.618	0.59	-
SUB	8	329.958	15.85	Sig..
SUB*TIME	24	40.476	0.65	-
ERROR	32	83.363		

Table 4-2-4: ANOVA for analysis of visual stress as a function of time.

Source	df	SS	F value	Finding
SUB	9	983.749	68.21	Sig.
COND	1	95.130	8.97	Sig.
SUB*COND	9	95.490	6.62	Sig.
DISPLAY	1	25.676	1.94	-
SUB*DISPLAY	9	118.881	8.24	Sig.
COND*DISPLAY	1	1.552	0.96	-
SUB*COND*DISPLAY	9	14.523	1.01	-
ERROR	200	320.518		

Table 4-2-5: ANOVA for analysis of induced fatigue.

Significance of (SUB*DISPLAY) implies that some subjects found one of the two displays more fatiguing. Significance of (SUB*COND), on the other hand, confirms the similar findings of Experiment-I. A combination of any of the followings (including their interaction) may explain the significance of above factors:

a- Possible differences among subjects in their previous exposure and experience with VDTs.

b- Possible differences among subjects in their susceptibility to stress and fatigue as a result of work in general and visual work on VDTs in particular.

CHAPTER V

CONCLUSIONS AND SUGGESTIONS FOR FURTHER STUDY

Character generation method is a significant factor in character definition. Some of the tested characters in this study showed to be more legible when generated by stroke method than by a 7x7 dot matrix. A 7x7 dot matrix, however, is suggested to be sufficient for generation of uppercase letters as the difference between the two generation methods in their overall legibility of the tested characters was statistically insignificant.

Character width to height ratio is also a significant factor in character definition. Two displays with the same polarity and same dot matrix resolutions but with different character width to height ratios, showed significant differences in legibility of 2 of the character pairs tested. No general conclusion can, however, be stated as the possible effects of this factor appears to depend on the characters shape and pecularities.

Raster lines in positive image polarities degrade the legibility of characters. The display with positive polarity in this study showed to be the worst among the four tested displays on the basis of its overall legibility.

As a result of 50 minutes of paced visual work, a small but significant decline in flicker frequency was observed. The

difference between displays, however, was not significant. Thus it can be concluded that, for short time periods, reading from a VDT screen may not be necessarily more stressfull or fatiguing than that from a paper display.

Image polarity had insignificant effect on blinking rate of subjects and thus it may be concluded that both polarities are equally stressfull on users vision.

Insignificance of image polarity was also shown in the analysis of the results for flicker tests. The significant decline in flicker frequencies was the same for both polarities and thus suggest no significant difference in the levels of induced fatigue as a result of working on different polarities.

Both blinking rate and performance remained unaffected throughout 2 hours of an unpaced visual search task. This implies that although some fatigue was recorded, visual performance did not deteriorate as a result of the fatigue.

Although no performace degradation or visual stress were observed, it should be, however, stated that additional studies may be needed in order to be able to generalize above conclusions to all VDT related tasks. In the experiments of this study, subjects worked on their own pace in a task that required very low levels of mental activity. Such conditions may not hold for many VDT related tasks and they may require higher levels of mental activity as well as vision work.

Additional studies are, therefore, suggested to investigate performance and visual stress in professional VDT users at work and for longer periods of time.

In doing so, a methodology similar to the one presented in this study may be employed. Moreover, it may be useful to monitor and record subjects' blinking duration in addition to its frequency. This is also a good indicator of stress. Minor modifications in computer programs, used in this study, can accommodate for measuring blinking durations.

It is anticipated that findings of such studies would be of great significance for proposing proper work-rest scheduals in VDT tasks.

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APPENDIX-A

SURVEY OF RECOMMENDATIONS

As a result of recent investigation, shown in latest studies pertaining to Visual Display Terminals (VDT), on better workstation design, proper posture when working with these units, ergonomic design of VDTs, etc, researchers have proposed a number of recommendations or suggestions. Although most of these are are subjectively proposed and their validity is not tested, it appears that ergonomical aspects of above issues have been well considered by the researchers.

These suggestions are divided into the following categories as they apply to each aspect of study of VDTs:

1- Machine Related,

2- Workstation Design,

3- Postural,

4- Work Management.

Sources of these standards are Rupp [1981], Cakir, et al [1980], and Gladman [1976].

KEY:

DIN:	Deutsche Industrie Norm
TUB:	Technical University, Berlin.
U of L:	University of London.
GREV:	Groupe de Recherche sur les Ecrans de Visualization.
DCIEM:	Canadian Defence and Civil Institute of Environmental Medicine.
VDT:	VDT manual by Cakir, et al [1980].
NIOSH:	National Institute for Occupational Safety and Health.

1- MACHINE RELATED:

1.1. Symbol Contrast:

TUB: 500% to 1000% with a background of least 20 cd/m2.

DIN: 3:1 minimum; 6:1 preferred; 15:1 maximum, With a minimum background of 10 cd/m2.

DCIEM Minimum of 4:1 in an ambient of 75 to 100 ft.cd.

VDT: 3:1 minimum; 8:1 to 10:1 optimum, with a background luminance of between 15 and 20 cd/m2.

1.2. Symbol Luminance:

DCIEM: Minimum of 85 cd/m2.

VDT: minimum of 45 cd/m2, 80 to 160 cd/m2 preferred.

1.3. Color of Symbols:

TUB: yellow green. Symbol and background colors similar.

DIN: Green through orange

DCIEM: green or white.

VDT: personal preference.

GREV: Red avoided.

1.4. Image polarity:

TUB: positive. (Dark symbols on a light background)

GREV: positive.

1.5. Minimum Referesh Rate:

TUB: 50 Hz.

DIN: 50 Hz.

U of L: 50 to 60 Hz.

DCIEM: 60 frames per second.

VDT: 50 to 60 Hz.

1.6. Character Format:

TUB: Vertical.

DIN: 5*7 minimum; with a capital letter width of 50 to 70% of the character height.

DCIEM: 5*7 minimum.

VDT: 5*7 minimum.
7*9 or greater preferred.
capital letter width of 70 to 80% of height.

1.7. Symbol Size:

TUB: Minimum 16 min. of arc high.
20 min. of arc high, preferred.

DIN: 18 min. of arc high for viewing distances greater than 50 cm.
2.6 mm high for viewing distances less than 50 cm.

U of L: 3.1 to 4.2 mm for viewing distance of 70 cm.

DCIEM: 3.5 mm minimum.

VDT: Minimum of 16 to 20 min.of arc high.
Minimum of 3.1 to 4.2 mm heigh.

Gladman: Width to heigh ratio of 0.75-0.80.

1.8. Character Line/Column Spacing:

TUB: Between character spacing of 50% of character width.

DIN: A minimum of 10% of character width between characters.
A minimum of 10% of character height between lines.

U of L: One character height between lines.
One half character width between lines.

VDT: 100 to 150% of character height between lines.
20% to 50% of character height between characters.

Gladman: Half-character's width between characters, and at least one character's height between lines.

1.9. Keyboard Factors:

1.9.1. Keystroke Feedback:

TUB: Tactile feedback

VDT: Tactile, acoustic, or snap action.

Gladman: Audible feedback.

1.9.2. Key Actuation Force:

TUB: 0.26 to 1.5 N.

VDT: 0.25 to 1.5 N.

1.9.3. Key Spacing:

TUB: 20 mm centers.

VDT: 18 to 20 mm centers.

1.9.4. Key Top Dimensions:

TUB: 13 mm.

VDT: 15 to 20 mm.

1.9.5. Numeric Block:

TUB: Calculator format is preferred over telephone format. Numeric block should be used when large amounts of numeric data is to be entered.

DIN: A numeric block, locatable to the right or left of the core should be provided for tasks requiring significant numeric input.

VDT: telephone format preferred over calculator format.

2. WORKSTATION DESIGN:

2.1. Workstation Dimensions:

TUB: Table height, 720 mm for fixed table height.
650 to 750 mm for adjustable table height.
Knee heigt, 690 mm.

DIN: Table height, 720 mm for fixed and 650 to 750 mm for adjustable table height.
Knee height, 650 mm minimum, 690 mm preferred.
Width, 1200 mm minimum, 1600 mm if other tasks are performed at workstation.

Gladman: Operator spacing (center-to-center distance between two workstations) of at least 71 cm.
Leg room width: At least 46 cm at knee height, and 61 cm at foot level.
Leg room depth: 46 cm or more at knee height and 61 cm or more at foot level.

2.2. Height of Display:

TUB: The height of display should be such that the line of sight, when looking at the center of the screen, would form a 20 deg. angle from the horizontal.

DIN: The upper edge of the screen must be within a range of from 37 to 52 cm from the work surface.

DCIEM: Center of screen to be 10 to 20 deg. below the observer's eye position.

VDT: Upper edge of the screen at or below eye height.

2.3. Screen Orientation:

TUB: Vertical.

DIN: Vertical if not adjustable.

If adjustable, not more than 5 deg. forward and not more than 20 deg. back from the vertical.

DCIEM: Surface of the screen should be within 5 deg. of the plane normal to the line of sight.

2.4. Ambient-Light Levels:

Tub: 500 lx.

DIN: 300 to 500 lx for stations with negative image.
500 lx minimum for stations with positive image.
200 lx if the screen is tilted 20 deg.

U of L: 500 to 750 lx.

DCIEM: 50 to 100 ft-cd.

VDT: 300 to 500 lx.

2.5. Reflectivities of Workstation Surfaces:

TUB: Work surface reflectivity, not more than 0.6.

DIN: Work surface reflectivity between 0.3 to 0.5.

3. Postural:

3.1. Display Viewing Distance:

TUB: 50 cm.

DIN: 50 to 70 cm.

VDT: 70 cm. maximum.

4. Work Management:

4.1. Rest Pauses:

NIOSH: 15 minutes break after 2 hours of moderate visual work and 10 minutes each hour for jobs with high visual demand.

APPENDIX-B

```
0001          PROGRAM HRV0
      C       ************************************************************
      C       **  FOLLOWING PROGRAM (HRV0) READS IN 50 HEART-RATE VALUES  **
      C       **  BY SAMPLING 4 TIMES A SECOND THE ECG'S ANALOG OUTPUT    **
      C       **  (I.E., TICK=15).          THIS PROGRAM IS USED FOR      **
      C       **  CALIBERATION OF A/D CONVERTER IN CONJUNCTION WITH GRASS  **
      C       **  POLYGRAPH EQUIPMENT FOR MEASUREMENT OF THE HEART RATE   **
      C       ************************************************************
0002          LOGICAL*1 FNAME(9),ANSWER
0003          REAL LOWER,LS,LHALF
0004          DATA FNAME/' ',' ',' ',' ',' ',' ','.','C','A','L'/,IBELL/8199/
      C       ************************************************************
      C       **  THE PROGRAM FIRST ASKS SUBJECT'S INITIALS AND CONDITION **
      C       **  NUMBER AND THEN AWAITS USER'S COMMAND TO START DATA      **
      C       **  COLLECTION.                                             **
      C       ************************************************************
0005          TYPE 1
0006    1     FORMAT(' ENTER THE SUBJECT"S INITIALS, E.G., SGL OR SH  ')
0007          ACCEPT 10,(FNAME(J),J=1,3)
0008    10    FORMAT(3A1)
0009          TYPE 2
0010    2     FORMAT(' **  ENTER THE CONDITION NUMBER  **  E.G., 12')
0011          ACCEPT 11,(FNAME(J),J=4,5)
0012    11    FORMAT(2A1)
0013    3     FORMAT(' ** FILE NAME IS GOING TO BE **  ',9A1,'  **')
0014          IREC=1
      C       ************************************************************
      C       **  IN BELOW THE PROGRAM INSTRUCTS THE USER TO SET THE      **
      C       **  TACKOGRAPH FOR CALIBURATION OF THE UPPER AND LOWER SCALES**
      C       **  AS WELL AS THE BASE LINE (ZERO VALUE).                  **
      C       ************************************************************
0015          TYPE 20,IBELL
0016    20    FORMAT(' ',A1,' ******   TO CALIBERATE THE A/D CONVERTER : ')
0017          TYPE 21
0018    21    FORMAT(' SET THE TACK SWITCH TO CENTER, WHEN READY PRESS',
             *  ' RETURN KEY')
0019          ACCEPT 27,ANSWER
0020    27    FORMAT (6A1)
0021          TYPE 22
0022    22    FORMAT('      ********   WORKING!!   ********')
0023          SUM=0
0024          IHR=1
0025          DO 200 I=1,50
0026          J=ISLEEP(0,0,0,15)
0027          K=IADC(2)
0028    200   SUM=SUM+K
0029          ZERO=SUM/50
0030          CALL CLEAR
0031          TYPE 41,IBELL
0032    41    FORMAT(' ',A1,' SET THE TACK SWITCH TO -2CM, WHEN READY',
             *  ' PREES RETURN KEY')
0033          ACCEPT 27,ANSWER
0034          TYPE 42
0035    42    FORMAT('      ********   WORKING!!   ********')
0036          SUM=0
0037          DO 203 I=1,50
```

```
0038          J=ISLEEP(0,0,0,15)
0039          K=IADC(2)
0040    203   SUM=SUM+K
0041          LHALF=SUM/50
0042          CALL CLEAR
0043          TYPE 31,IBELL
0044    31    FORMAT(' ',A1,' SET THE TACK SWITCH TO +2 CM, WHEN READY',
             *   ' PRESS RETURN KEY')
0045          ACCEPT 27,ANSWER
0046          TYPE 32
0047    32    FORMAT('       ********     WORKING!!     ********')
0048          SUM=0
0049          DO 201 I=1,50
0050          J=ISLEEP(0,0,0,15)
0051          K=IADC(2)
0052    201   SUM=SUM+K
0053          UPHALF=SUM/50
0054          UPPER=UPHALF-ZERO
0055          LOWER=LHALF-ZERO
0056          SCALE=40
0057          IF(UPPER.NE.0)US=SCALE/UPPER
0059          IF(LOWER.NE.0)LS=SCALE/LOWER
0061          TYPE 90,IBELL,ZERO,LS,US
0062          TYPE 3,(FNAME(I),I=1,9)
0063    90    FORMAT(' 'A1,'ZERO VALUE =  ',F9.3,/
             *    ' ','LOWER SCALE =  ',F9.6/,
             *  ' ';'UPPER SCALE =  ',F9.6)
0064          STOP
0065          END
```

FORTRAN IV Storage Map for Program Unit HRV0

Local Variables, .PSECT $DATA, Size = 000102 (33. words)

Name	Type	Offset	Name	Type	Offset	Name	Type	Offset
ANSWER	L*1	000022	I	I*2	000052	IBELL	I*2	000012
IHR	I*2	000050	IREC	I*2	000042	J	I*2	000040
K	I*2	000054	LHALF	R*4	000034	LOWER	R*4	000024
LS	R*4	000030	SCALE	R*4	000072	SUM	R*4	000044
UPHALF	R*4	000062	UPPER	R*4	000066	US	R*4	000076
ZERO	R*4	000056						

Local and COMMON Arrays:

Name	Type	Section	Offset	Size	Dimensions
FNAME	L*1	$DATA	000000	000011 (5.)	(9)

Subroutines, Functions, Statement and Processor-Defined Functions:

Name	Type	Name	Type	Name	Type	Name	Type	Name	Type
CLEAR	R*4	IADC	I*2	ISLEEP	I*2				

```
FORTRAN IV      V02.5-2                                    PAGE 001

0001            SUBROUTINE CLEAR
0002            CALL PLOT55(2,,512)
0003            CALL PLOT55(9,0,0)
0004            CALL PLOT55(10,,)
0005            RETURN
0006            END
```

FORTRAN IV Storage Map for Program Unit CLEAR

Subroutines, Functions, Statement and Processor-Defined Functions:

Name	Type	Name	Type	Name	Type	Name	Type	Name	Type
PLOT55	R*4								

```
FORTRAN IV     V02:5-2                                          PAGE 001

0001          PROGRAM HRV1
      C       ************************************************************
      C       **  THE FOLLOWING PROGRAM(SAM1.FOR) READS IN 21,600 HEART-  **
      C       **  RATE VALUES AND 21,600 EYE-MOVEMENT (VERTICAL) VALUES   **
      C       **  AND STORES THEM UNDER THE NAME SPECIFIED BY THE USER    **
      C       **  AND FILE TYPE OF .DAT .  THESE ARE STORED ALTERNATIVELY  **
      C       **  AS SPECIFIED BY THE ORDER OF THE WRITE STATEMENT.        **
      C       **  ************************************************************  **
      C       **  THE PROGRAM READS AND STORES ABOVE VALUES FOR EVERY      **
      C       **  15 MINUTES. INITIALLY THE EXPERIMENTER IS ASKED TO ENTER **
      C       **  SUBJECT'S INITIALS AND EXPERIMENTAL CONDITION NUMBER, AS **
      C       **  THEY ARE ASKED BY THE PROGRAM. THEN THE PROGRAM WAITS    **
      C       **  FOR USER'S COMMAND TO START COLLECTING DATA. ONCE THIS   **
      C       **  COMMAND IS GIVEN THE PROGRAM IS NO LONGER UNDER USER'S   **
      C       **  CONTROL AND DATA WILL BE COLLECTED FOR THE ENTIRE SESSION**
      C       ************************************************************
0002          LOGICAL*1 FNAME(9)
0003          DATA FNAME/' ',' ',' ',' ',' ',' ','.','D','A','T'/
0004          TYPE 5
0005    5     FORMAT(' ','PRIOR TO EXECUTION OF THIS PROGRAM YOU SHOULD',
     *       ,' HAVE EXECUTED'/' ','THE PROGRAM SAM0.FOR TO CALIBERATE ADC')
0006          TYPE 1
0007    1     FORMAT(///,' ENTER THE SUBJECT"S INITIALS, E.G., SGL OR SH  ')
0008          ACCEPT 10,(FNAME(J),J=1,3)
0009    10    FORMAT(3A1)
0010          TYPE 2
0011    2     FORMAT(' **  ENTER THE CONDITION NUMBER  **  E.G., 12')
0012          ACCEPT 11,(FNAME(J),J=4,5)
0013    11    FORMAT(2A1)
0014          TYPE 14
0015    14    FORMAT('    WHEN READY, PRESS RETURN KEY.')
0016          ACCEPT 15,LEVEL
0017    15    FORMAT('    ',I6)
0018          TYPE 3,(FNAME(I),I=1,9)
0019    3     FORMAT(' ** FILE NAME IS GOING TO BE ** ',9A1,'  **')
0020          CALL ASSIGN(1,FNAME,9)
0021          IREC=1
0022          DEFINE FILE 1(21600,2,U,IREC)
0023          DO 201 II=1,4
0024          TYPE 205,II
0025          DO 200 I=1,5400
0026          J=ISLEEP(0,0,0,10)
0027          IHR=IADC(2)
0028          IEYE=IADC(14)
0029    200   WRITE(1'IREC) IHR,IEYE
0030          TYPE 203
0031    201   J=ISLEEP(0,15,0,0)
0032    203   FORMAT(' ','*** DATA COLLECTION HAS STOPED NOW ***',//
     *       ,'**** PROGRAM IS PUT TO TO SLEEP FOR THE NEXT 15 MINUTES ****')
0033    205   FORMAT(' ','*** DATA COLLECTION FOR PERIOD',I3,'HAS BEGUN ***',//)
0034          CALL CLOSE(1)
0035          STOP
0036          END
```

FORTRAN IV Storage Map for Program Unit HRV1

Local Variables, .PSECT $DATA, Size = 000036 (15. words)

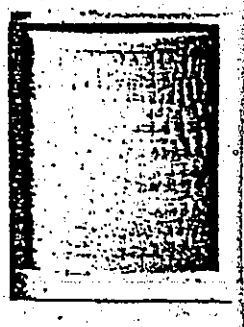
Name	Type	Offset	Name	Type	Offset	Name	Type	Offset
I	I*2	000024	IEYE	I*2	000034	IHR	I*2	000032
II	I*2	000030	IREC	I*2	000026 Eqv	J	I*2	000020
LEVEL	I*2	000022						

Local and COMMON Arrays:

Name	Type	Section	Offset	------Size------	Dimensions
FNAME	L*1	$DATA	000000	000011 (5.)	(9)

Subroutines, Functions, Statement and Processor-Defined Functions:

Name	Type	Name	Type	Name	Type	Name	Type	Name	Type
ASSIGN	R*4	CLOSE	R*4	IADC	I*2	ISLEEP	I*2		



```
0001          PROGRAM HRV2
      C     ***************************************************************
      C     **  THE FOLLOWING PROGRAM READS THE VALUES OF HEART RATE AND  **
      C     **  EYE-MOVEMENT AND GIVES THE HEART RATE VARIABILITY(1 VALUE)**
      C     **  AND TOTAL NUMBER OF BLINKS CORRESPONDING TO FOUR 15 MINUTE**
      C     **  PERIODS (4 VALUES OF EACH).                              **
      C     **  ********************************************************  **
      C     **  THE PROGRAM FIRST ASKS THE USER TO SUPPLY THE SCALING     **
      C     **  COEFFICIENTS, FOUND FROM PROGRAM (HRV0) AND THE FILE'S    **
      C     **  SPESIFICATIONS (I.E., SUBJECT'S INITIALS AND EXPERIMENTAL **
      C     **  CONDITION NUMBER).  THEN THE COMPUTATIONS ARE PERFORMED   **
      C     **  AND VALUES ARE PRINTED ON THE PRINTER.                    **
      C     ***************************************************************
0002          DIMENSION NBLINK(4),SUM(4),NNS(4),NPS(4),SCORE(4),IBEAT(4)
     *   ,MAXIMA(4),MINIMA(4)
0003          LOGICAL*1 FNAME(9)
0004          INTEGER OLDHR,ISUM(4)
0005          REAL LS,US
0006          DATA FNAME/' ',' ',' ',' ',' ',' ','.','D','A','T'/
0007          TYPE 1
0008    1     FORMAT(' ENTER THE SUBJECT"S INITIALS, E.G., SGL OR SH . ')
0009          ACCEPT 10,(FNAME(J),J=1,3)
0010   10     FORMAT(3A1)
0011          TYPE 2
0012    2     FORMAT(' **  ENTER THE CONDITION NUMBER  **  E.G., 12')
0013          ACCEPT 11,(FNAME(J),J=4,5)
0014   11     FORMAT(2A1)
0015          TYPE 3,(FNAME(I),I=1,9)
0016    3     FORMAT(' ** FILE NAME YOU ARE REFFERING TO IS: **  ',9A1,'  **')
0017          TYPE 5
0018    5     FORMAT(' ',' NOW ENTER THE FOLOWING VALUES AS THEY APPEAR ON THE',
     *  ' ',' SCREEN',//)
0019          TYPE 8
0020          ACCEPT 6,ZERO
0021    8     FORMAT(' ENTER THE VALUE OF ZERO(F10.5):'$)
0022          TYPE 9
0023          ACCEPT 7,LS
0024    7     FORMAT(F10.7)
0025    9     FORMAT(' ENTER THE VALUE OF L.S(F10.7):'$)
0026          TYPE 24
0027          ACCEPT 7,US
0028   24     FORMAT(' ENTER THE VALUE OF U.S(F10.7):'$)
0029    6     FORMAT(F10.5)
0030          TYPE 96
0031   96     FORMAT('  *** VERIFY THE FOLLOWING:  ***'//)
0032          TYPE 97,ZERO,LS,US
0033   97     FORMAT(' ',' VALUE OF ZERO IS  ',F10.5,/
     *  ,'  VALUE OF L.S. IS  ',F10.7,/
     *  ,'  VALUE OF U.S. IS  ',F10.7,/)
0034          CALL ASSIGN(1,FNAME,9)
0035          IREC=1
0036          DEFINE FILE 1(21600,2,U,IREC)
      C     ***************************************************
      C     **  INITIALIZATION OF THE VARIABLES:             **
      C     ***************************************************
0037          IAHR=0
```

```
0038          ICOUNT=0
0039          DO 901 KK=1,4
0040          NPS(KK)=0
0041          IBEAT(KK)=0
0042          MAXIMA(KK)=0
0043          MINIMA(KK)=0
0044          NNS(KK)=0
0045    901   ISUM(KK)=0
0046          IDUMMY=0
0047          IFLAG=0
0048          IC=0
0049          INDEX=0
0050          IVALUE=0
0051          DO 200 I=1,4
0052          NBLINK(I)=0
0053          DO 200 J=1,5400
0054          READ(1'IREC) IHR,NTICK
        C     ***************************************************************
        C     **  CHECKING FOR SUDDEN CHANGES IN CODED VALUES CORRESPONDING **
        C     **  TO EYE MOVEMENTS.                                        **
        C     ***************************************************************
0055          DIFF=NTICK-IVALUE
0056          FACTOR=ABS(DIFF/NTICK)
0057          IF(DIFF.LE.0.OR.IFLAG.GT.2.OR.IFLAG.EQ.0)GO TO 156
0059          IF(FACTOR.LT.0.05.AND.IFLAG.EQ.1)GO TO 156
0061          IFLAG=0
0062          IF((INDEX-IC).GE.6)NBLINK(I)=NBLINK(I)+1
0064          IC=INDEX
0065    156   IF(IFLAG.NE.0)GO TO 132
0067          IF(FACTOR.LE.0.10)GO TO 145
0069    132   IF(DIFF.GE.0)GO TO 145
0071          IFLAG=IFLAG+1
0072          GO TO 146
0073    145   IFLAG=0
0074    146   IVALUE=NTICK
0075          IF(IFLAG.GT.2)IFLAG=0
0077          INDEX=INDEX+1
0078          IHALF=(INDEX/5400)+1
        C     ***************************************************************
        C     **  CONVERSION FROM CODED VALUES TO HEART RATES USING        **
        C     **  THE CONVERSION FACTORS OF PROGRAM (HRV0).                **
        C     ***************************************************************
0079          HR=IHR
0080          HEART=HR-ZERO
0081          IF(HEART)300,300,301
0082    301   HR=80-HEART*LS
0083          GO TO 302
0084    300   HR=80+HEART*US
0085    302   NEWHR=(HR+.05)*10.0
        C     ***************************************************************
        C     **  CHECKING FOR POSSIBLE CHANGES IN HEART RATES.  IF        **
        C     **  CHANGES HAVE OCCURED THEN THE HEART RATE VARIABILITY**
        C     **  INDECIS ARE UPDATED.                                     **
        C     ***************************************************************
0086          IF(IABS(OLDHR-NEWHR).LT.5)GO TO 321
0088          IBEAT(IHALF)=IBEAT(IHALF)+1
```

```
FORTRAN IV     V02.5-2                                          PAGE 003

0089            IF(NEWHR.GT.OLDHR)GO TO 320
0091            NNS(IHALF)=NNS(IHALF)+1
0092            IF(ISIGN.NE.1)MINIMA(IHALF)=MINIMA(IHALF)+1
0094            ISIGN=1
0095            ISUM(IHALF)=ISUM(IHALF)+(OLDHR-NEWHR)
0096            GO TO 321
0097  320       NPS(IHALF)=NPS(IHALF)+1
0098            IF(ISIGN.NE.0)MAXIMA(IHALF)=MAXIMA(IHALF)+1
0100            ISIGN=0
0101  321       OLDHR=NEWHR
0102  200       CONTINUE
0103            PRINT 607,(FNAME(I),I=1,9)
0104  607       FORMAT(' ************************************************'/
     *     ,' ********   FILE NAME IS: **  ',9A1,'  **********'/
     *     ,' ************************************************'///)
0105            DO 600,III=1,4
0106            SCORE(III)=ISUM(III)/(10.0*(MAXIMA(III)+MINIMA(III)))
0107            PRINT 602,III
0108  602       FORMAT(' **** PERIOD IS: ',I2/
     *           ,' ******************'/)
0109  600       PRINT 601,NNS(III),NPS(III),ISUM(III),MAXIMA(III),MINIMA(III)
     *     ,IBEAT(III),SCORE(III),NBLINK(III)
0110  601       FORMAT(' *** NUMBER OF NEGATIVE POINTS IS: ',I8/
     *           ' *** NUMBER OF POSITIVE POINTS IS: ',I8/
     *           ' *** SUM OF HR"S, WHEN DECREASING: ',I8/
     *           ' *** NUMBER OF RELATIVE MAXIMA IS: ',I8/
     *           ' *** NUMBER OF RELATIVE MINIMA IS: ',I8/
     *           ' *** NUMBER OF BEATS IS :          ',I8/
     *           ' *** SCORE IS :                    ',F10.5/
     *           ' *** NUMBER OF BLINKS IS:          ',I8/
     *           ' ************************************************'/)
0111            STOP
0112            END
```

FORTRAN IV Storage Map for Program Unit HRV2

Local Variables, .PSECT $DATA, Size = 000316 (103. words)

Name	Type	Offset	Name	Type	Offset	Name	Type	Offset	
DIFF	R*4	000260	FACTOR	R*4	000264	HEART	R*4	000276	
HR	R*4	000272	I	I*2	000224	IAHR	I*2	000234	
IC	I*2	000246	ICOUNT	I*2	000236	IDUMMY	I*2	000242	
IFLAG	I*2	000244	IHALF	I*2	000270	IHR	I*2	000254	
III	I*2	000306	INDEX	I*2	000250	IREC	I*2	000232	Eqv
ISIGN	I*2	000304	IVALUE	I*2	000252	J	I*2	000222	
KK	I*2	000240	LS	R*4	000212	NEWHR	I*2	000302	
NTICK	I*2	000256	OLDHR	I*2	000210	US	R*4	000216	
ZERO	R*4	000226							

Local and COMMON Arrays:

Name	Type	Section	Offset	------Size------	Dimensions
FNAME	L*1	$DATA	000120	000011 (5.)	(9)
IBEAT	I*2	$DATA	000070	000010 (4.)	(4)
ISUM	I*2	$DATA	000132	000010 (4.)	(4)
MAXIMA	I*2	$DATA	000100	000010 (4.)	(4)
MINIMA	I*2	$DATA	000110	000010 (4.)	(4)
NBLINK	I*2	$DATA	000000	000010 (4.)	(4)
NNS	I*2	$DATA	000030	000010 (4.)	(4)
NPS	I*2	$DATA	000040	000010 (4.)	(4)
SCORE	R*4	$DATA	000050	000020 (8.)	(4)
SUM	R*4	$DATA	000010	000020 (8.)	(4)

Subroutines, Functions, Statement and Processor-Defined Functions:

Name	Type	Name	Type	Name	Type	Name	Type	Name	Type
ABS	R*4	ASSIGN	R*4	IABS	I*2				

APPENDIX-C.1

****
*** PERFORMANCE SHEET ***
****

Subject: AMC Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	2/4, 1/2, 0/3, 2/3, 2/2, 0/1, 0/1, 3/4	10/20
S & 5	4/4, 2/2, 3/3, 2/2, 3/3, 2/2, 2/2, 2/2	20/20
K & X	2/2, 2/2, 5/5, 1/1, 1/1, 3/3, 4/4, 2/2	20/20
U & V	2/2, 2/2, 3/4, 2/2, 3/3, 0/2, 4/4, 1/1	17/20
D & O	1/2, 2/3, 2/3, 1/4, 1/1, 3/3, 1/1, 2/3	13/20
SIMPLE (CR)	1/1, 2/3, 2/2, 2/2, 4/4, 2/3, 1/3, 2/2	16/20

DISPLAY #: 1

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	3/4, 0/1, 2/2, 2/2, 0/3, 0/3, 2/4, 0/1	9/20
S & 5	1/2, 4/4, 3/3, 2/2, 1/2, 2/2, 2/2, 3/3	18/20
K & X	3/3, 1/1, 2/2, 1/1, 2/2, 2/2, 4/5, 4/4	19/20
U & V	1/1, 2/4, 2/2, 1/2, 1/2, 3/3, 2/2, 2/4	14/20
D & O	3/3, 2/4, 1/3, 1/1, 1/2, 1/3, 1/3, 0/1	10/20
SIMPLE	1/2, 2/3, 1/3, 2/2, 4/4, 1/1, 0/2, 2/3	13/20

DISPLAY #: 2

COMMENTS: DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

11

****
*** PERFORMANCE SHEET ***
****

Subject: AMC Date:----------

DISPLAY #: 3

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/3, 2/2, 3/3, 1/1, 2/2, 2/4, 3/4, 0/1	15/20
S & 5	2/2, 2/2, 2/2, 2/2, 3/3, 1/2, 1/2, 3/4	17/20
K & X	2/2, 3/3, 1/1, 4/5, 2/2, 1/1, 2/2, 4/4	19/20
U & V	1/4, 3/4, 1/2, 0/2, 0/2, 2/2, 3/3, 1/1	11/20
D & O	1/3, 0/1, 2/3, 1/3, 2/3, 1/1, 1/2, 2/4	10/20
SIMPLE (CR)	2/2, 2/3, 3/3, 1/2, 1/2, 3/4, 1/1, 1/3	14/20

COMMENTS:

==========

DISPLAY #: 4

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/2, 2/4, 1/3, 0/2, 2/4, 0/1, 1/3, 0/1	8/20
S & 5	4/4, 2/2, 1/2, 2/2, 3/3, 2/3, 2/2, 2/2	18/20
K & X	1/1, 5/5, 2/2, 2/2, 3/3, 1/1, 2/2, 4/4	20/20
U & V	2/2, 2/01, 4/4; 2/2, 2/2, 3/3, 1/1, 0/2	16/20
D & O	2/3, 2/3, 2/3, 2/3, 0/1, 1/1, 1/2, 3/4	13/20
SIMPLE	3/3, 2/2, 2/2, 3/3, 4/4, 1/1, 2/2, 1/3	18/20

COMMENTS:

11

90

****
*** PERFORMANCE SHEET ***
****

Subject: PAC Date: ----------

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	3/4, 0/3, 3/3, 0/1, 0/2, 1/2, 0/1, 4/4	11/20
S & 5	2/2, 2/2, 3/3, 2/2, 2/2, 4/4, 3/5, 2/2	20/20
K & X	2/4, 1/2, 0/1, 2/2, 3/3, 0/1, 2/2, 5/5	15/20
U & V	1/2, 3/3, 3/4, 2/2, 0/2, 1/1, 3/4, 2/2	15/20
D & O	3/3, 2/3, 3/3, 2/4, 1/2, 1/1, 2/3, 1/1	15/20
SIMPLE	1/2, 2/2, 3/4, 1/1, 1/3, 2/3, 3/3, 2/2	15/20

DISPLAY #: 1

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/2, 3/4, 1/1, 3/3, 1/1, 2/2, 2/3, 3/4	17/20
S & 5	1/3, 1/2, 1/2, 2/2, 2/2, 3/3, 2/2, 3/4	15/20
K & X	3/3, 2/2, 4/5, 2/2, 4/4, 1/1, 2/2, 1/1	19/20
U & V	3/4, 1/1, 1/2, 2/4, 2/2, 2/2, 2/2, 3/3	18/20
D & O	1/1, 3/3, 2/3, 0/1, 1/2, 3/3, 2/3, 3/4	15/20
SIMPLE	2/2, 3/3, 1/1, 4/4, 1/2, 2/3, 2/3, 2/2	17/20

DISPLAY #: 2

COMMENTS:

****
*** PERFORMANCE SHEET ***
****

Subject: PAC Date:

DISPLAY #: 3

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	1/3, 2/2, 3/3, 1/1, 2/2, 2/4, 3/4, 1/1	15/20
S & 5	2/2, 2/2, 1/2, 2/2, 3/3, 2/3, 1/2, 4/4	17/20
K & X	2/2, 3/3, 1/1, 4/5, 2/2, 1/1, 2/2, 3/4	18/20
U & V	3/4, 3/4, 1/2, 0/2, 0/2, 2/2, 3/3, 1/1	13/20
D & O	2/3, 0/1, 2/3, 2/3, 2/3, 1/1, 2/2, 1/4	12/20
SIMPLE	1/1, 2/3, 2/2, 1/2, 4/4, 1/1, 3/3, 1/2	17/20

COMMENTS:

DISPLAY #: 4

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/2, 3/4, 3/3, 1/2, 3/4, 0/1, 2/3, 0/1	14/20
S & 5	2/4, 2/2, 2/2, 2/2, 3/3, 2/3, 2/2, 2/2	17/20
K & X	1/1, 5/5, 2/2, 2/2, 3/3, 1/1, 2/2, 3/4	19/20
U & V	1/2, 1/2, 3/4, 2/4, 0/2, 2/2, 3/3, 0/1	12/20
D & O	2/3, 2/3, 1/3, 1/3, 1/1, 1/1, 0/2, 1/4	9/20
SIMPLE	2/3, 1/2, 1/2, 1/3, 3/4, 1/1, 1/2, 3/3	13/20

COMMENTS:

****
*** PERFORMANCE SHEET ***
****

Subject: TKJ Date:

DISPLAY #: 1

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	2/4, 0/2, 0/3, 1/1, 2/4, 0/3, 2/2, 0/1	7/20
S & 5	3/4, 2/2, 3/3, 2/2, 2/2, 2/2, 2/3, 2/2	18/20
K & X	3/3, 1/2, 2/2, 1/1, 1/1, 1/2, 3/4, 4/5	16/20
U & V	3/3, 1/2, 1/1, 3/4, 4/4, 1/2, 2/2, 2/2	17/20
D & O	3/3, 1/2, 2/3, 4/4, 1/1, 1/3, 1/1, 3/3	16/20
SIMPLE	2/3, 1/2, 2/3, 0/2, 1/1, 4/4, 2/3, 2/2	14/20

COMMENTS:

DISPLAY #: 2

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	0/3, 2/4, 1/2, 1/1, 1/3, 1/1, 2/2, 2/4	10/20
S & 5	3/3, 3/4, 2/2, 1/2, 2/2, 1/2, 1/2, 3/3	16/20
K & X	1/1, 1/2, 2/3, 2/2, 1/1, 2/2, 3/5, 4/4	16/20
U & V	2/2, 2/2, 1/2, 4/4, 2/4, 0/1, 1/2, 3/3	15/20
D & O	1/1, 1/3, 0/3, 0/3, 2/4, 1/1, 2/3, 2/3	9/20
SIMPLE	1/2, 1/1, 0/2, 1/3, 2/3, 3/4, 2/3, 2/2	12/20

COMMENTS:

****
*** PERFORMANCE SHEET ***
****

Subject: TKJ Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	3/3, 2/2, 2/3, 1/1, 1/2, 3/4, 3/4, 0/1	15/20
S & 5	1/2, 2/2, 1/2, 2/2, 3/3, 1/2, 2/2, 4/4	17/20
K & X	2/2, 2/3, 1/1, 4/5, 2/2, 1/1, 1/2, 3/4	16/20
U & V	4/4, 2/4, 2/2, 2/2, 1/2, 2/2, 3/3, 0/1	16/20
D & O	2/3, 1/1, 3/3, 1/3, 2/3, 1/1, 2/2, 3/4	15/20
SIMPLE	1/2, 2/3, 2/3, 2/2, 4/4, 1/1, 2/3, 2/2	16/20

DISPLAY #: 3

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/1, 1/3, 1/1, 1/4, 0/3, 0/2, 0/2, 1/1	4/20
S & 5	3/4, 1/2, 2/2, 0/2, 3/3, 0/2, 3/3, 2/2	14/20
K & X	1/2, 2/3, 1/1, 0/1, 2/2, 4/4, 4/5, 2/2	16/20
U & V	3/4, 2/2, 3/4, 1/2, 2/2, 1/2, 3/3, 1/1	16/20
D & O	2/2, 2/3, 2/4, 0/3, 2/3, 1/3, 0/1, 1/1	10/20
SIMPLE	1/2, 2/3, 2/2, 1/2, 2/3, 3/4, 1/1, 3/3	15/20

DISPLAY #: 4

COMMENTS:

11

****
*** PERFORMANCE SHEET ***
****

Subject: JSS Date:----------

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	1/1, 0/1, 4/4, 2/2, 2/2, 3/3, 2/4, 3/3	17/20
S & 5	1/2, 2/2, 3/3, 2/2, 3/3, 2/2, 4/4, 2/2	19/20
K & X	4/4, 3/3, 2/2, 5/5, 2/2, 1/1, 1/1, 2/2	20/20
U & V	2/2, 2/2, 0/1, 1/4, 2/3, 1/2, 4/4, 0/2	12/20
D & O	1/4, 2/2, 2/3, 2/3, 2/3, 2/3, 1/1, 1/1	13/20
SIMPLE	3/4, 2/3, 1/3, 1/2, 2/3, 1/1, 2/2, 2/2	14/20

DISPLAY #: 1

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/2, 3/3, 3/4, 1/1, 3/3, 1/1, 2/2, 3/4	18/20
S & 5	2/2, 4/4, 3/3, 1/2, 2/2, 2/2, 1/2, 3/3	18/20
K & X	2/2, 3/3, 1/1, 1/2, 3/4, 2/2, 3/5, 1/1	16/20
U & V	2/2, 0/1, 0/2, 1/4, 0/2, 4/4, 2/2, 3/3	12/20
D & O	1/1, 1/3, 3/3, 0/1, 0/2, 2/3, 0/3, 2/4	9/20
SIMPLE	1/2, 1/1, 2/3, 1/2, 2/3, 3/3, 2/4, 2/2	15/20

DISPLAY #: 2

COMMENTS:

11

****
*** PERFORMANCE SHEET ***
****

Subject: JSS Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	2/3, 1/2, 3/3, 1/1, 1/2, 3/4, 3/4, 9/1	14/20
S & 5	2/2, 2/2, 2/2, 2/2, 3/3, 2/2, 3/4, 3/3	19/20
K & X	2/2, 3/3, 1/1, 4/5, 1/1, 2/2, 1/2, 4/4	18/20
U & V	1/4, 3/4, 1/2, 1/2, 0/2, 2/2, 3/3, 1/1	12/20
D & O	2/3, 0/2, 2/3, 1/3, 2/3, 1/4, 1/2, 1/4	10/20
SIMPLE	1/2, 1/3, 2/3, 1/2, 1/2, 3/4, 1/1, 2/3	12/20

DISPLAY #: 3

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	0/1, 1/3, 1/1, 3/4, 2/3, 2/2, 1/2, 1/4	11/20
S & 5	2/4, 2/2, 1/2, 1/2, 3/3, 2/2, 3/3, 1/2	15/20
K & X	1/2, 3/3, 1/1, 1/1, 2/2, 3/4, 3/5, 2/2	16/20
U & V	1/4, 2/2, 3/4, 1/2, 2/2, 0/2, 2/3, 1/1	12/20
D & O	2/2, 0/3, 2/4, 2/3, 3/3, 1/3, 9/1, 9/1	10/20
SIMPLE	1/2, 3/3, 1/2, 1/2, 1/3, 3/4, 1/1, 3/3	14/20

DISPLAY #: 4

COMMENTS:

11

****
*** PERFORMANCE SHEET ***
****

Subject: GMS Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/2, 1/2, 2/3, 4/4, 1/1, 0/1, 2/3, 3/4	13/20
S & 5	1/2, 1/3, 2/2, 2/2, 2/2, 3/3, 4/4, 2/2	17/20
K & X	2/2, 1/2, 3/3, 2/2, 5/5, 1/1, 1/1, 2/4	17/20
U & V	1/2, 3/4, 0/1, 1/2, 3/4, 2/2, 2/2, 3/3	15/20
D & O	0/2, 1/4, 2/3, 2/3, 3/3, 1/1, 1/1, 2/3	12/20
SIMPLE	3/3, 3/3, 2/2, 1/2, 4/4, 1/1, 3/3, 2/2	19/20

DISPLAY #: 1

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	4/4, 2/3, 1/1, 3/4, 2/2, 1/1, 2/3, 2/2	17/20
S & 5	2/2, 2/3, 4/4, 2/2, 2/2, 2/2, 2/2, 2/2	19/20
K & X	2/4, 1/1, 2/2, 5/5, 1/1, 2/2, 1/3, 2/3	16/20
U & V	3/4, 1/2, 2/2, 3/4, 1/2, 1/1, 2/2, 3/3	16/20
D & O	1/2, 2/3, 1/3, 3/3, 1/1, 3/4, 1/1, 0/3	12/20
SIMPLE	1/2, 4/4, 3/3, 3/3, 2/3, 1/1, 1/2, 2/2	17/20

DISPLAY #: 2

COMMENTS:

11

97

****
*** PERFORMANCE SHEET ***
****

Subject:---------- Date:----------

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/3, 2/2, 2/3, 1/1, 2/2, 4/4, 2/4, 1/1	14/20
S & 5	2/2, 2/2, 2/2, 2/2, 2/3, 3/3, 1/2, 2/4	16/20
K & X	2/2, 2/3, 1/1, 4/5, 1/2, 1/1, 2/2, 3/4	16/20
U & V	1/4, 2/4, 1/2, 2/2, 1/2, 2/2, 3/3, 1/1	13/20
D & O	1/3, 1/1, 2/3, 1/3, 3/3, 1/1, 1/2, 2/4	12/20
SIMPLE	2/2, 2/3, 3/3, 2/2, 2/2, 3/4, 1/1, 3/3	18/20

DISPLAY #: 3

COMMENTS:

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TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/2, 2/4, 2/2, 0/1, 1/3, 1/1, 2/4, 1/3	9/20
S & 5	2/2, 2/3, 2/2, 1/2, 3/3, 2/2, 1/2, 2/4	15/20
K & X	2/2, 3/3, 2/2, 1/1, 1/2, 1/1, 4/5, 3/4	17/20
U & V	3/3, 2/4, 1/2, 2/2, 1/2, 2/2, 2/4, 1/1	14/20
D & O	2/4, 3/3, 0/1, 1/1, 1/2, 2/3, 3/3, 1/3	13/20
SIMPLE	4/4, 3/3, 2/2, 1/2, 1/2, 3/3, 1/1, 3/3	18/20

DISPLAY #: 4

COMMENTS:

11

98

****
*** PERFORMANCE SHEET ***
****

Subject: EZP Date: ----------

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	9/3, 0/1, 3/3, 1/2, 1/4, 9/1, 0/4, 2/2	7/20
S & 5	9/2, 1/2, 3/3, 3/3, 2/2, 3/4, 2/1, 2/2	18/20
K & X	9/2, 2/2, 2/3, 1/1, 3/5, 1/1, 2/2, 4/4	17/20
U & V	2/4, 1/1, 2/3, 4/4, 1/2, 1/2, 1/2, 2/2	14/20
D & O	1/1, 2/2, 1/1, 3/3, 2/3, 3/3, 2/4, 2/3	16/20
SIMPLE (CR)	2/3, 1/2, 3/4, 1/1, 2/2, 3/3, 2/2, 2/3	16/20

DISPLAY #: 1

COMMENTS:

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TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	2/3, 2/2, 1/4, 2/2, 3/4, 1/1, 2/3, 1/1	14/20
S & 5	1/2, 1/2, 3/3, 2/3, 1/2, 1/2, 4/4, 2/2	15/20
K & X	3/4, 4/5, 2/2, 1/1, 0/1, 2/2, 3/3, 2/2	17/20
U & V	2/2, 1/2, 0/1, 2/3, 0/2, 2/4, 3/4, 2/2	12/20
D & O	2/3, 3/4, 0/3, 1/1, 2/3, 3/3, 0/1, 1/2	12/20
SIMPLE	3/3, 1/2, 2/2, 1/2, 2/3, 1/1, 3/3, 4/4	17/20

DISPLAY #: 2

COMMENTS:

11

99

****
*** PERFORMANCE SHEET ***
****

Subject: FZP Date:

DISPLAY #: 3

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/3, 1/2, 2/3, 1/1, 2/2, 4/4, 2/4, 1/2	13/20
S & 5	0/2, 1/2, 2/2, 2/2, 2/3, 2/3, 2/2, 3/4	14/20
K & X	2/2, 3/3, 1/1, 2/2, 1/1, 1/2, 4/4, 5/5	18/20
U & V	2/4, 2/4, 2/2, 2/2, 1/3, 0/1, 0/2	11/20
D & O	3/3, 0/1, 2/3, 2/3, 3/3, 1/1, 2/2, 2/4	15/20
SIMPLE	1/2, 2/3, 2/3, 2/2, 1/2, 4/4, 1/1, 1/3	14/20

COMMENTS:

DISPLAY #: 4

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/3, 0/4, 0/2, 0/1, 2/3, 0/1, 0/4, 0/3	4/20
S & 5	2/2, 0/2, 2/3, 1/2, 2/2, 1/2, 1/3, 2/4	11/20
K & X	2/2, 4/4, 3/5, 3/3, 0/2, 1/1, 2/2, 1/1	16/20
U & V	0/2, 2/3, 2/4, 0/2, 2/2, 0/4, 0/1, 0/2	6/20
D & O	0/4, 2/3, 1/2, 0/1, 0/2, 2/3, 1/3, 1/3	7/20
SIMPLE	1/1, 3/3, 2/3, 2/3, 2/2, 0/2, 1/2, 3/4	14/20

COMMENTS:

100

****
*** PERFORMANCE SHEET ***
****

Subject: NIV — Date: ----------

DISPLAY #: 1

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	%, %, %, %, %, %, %, %	0/20
S & 5	3/3, 3/4, 2/2, 2/2, 2/2, 3/3, 2/2, 2/2	19/20
K & X	2/2, 1/1, 4/5, 2/2, 3/3, 1/1, 3/3, 3/4	18/20
U & V	1/1, 4/4, 2/2, 2/2, 3/3, 2/2, 2/2, 3/4	18/20
D & O	3/3, 1/3, 3/3, 1/1, 2/2, 1/1, 2/2, 1/4	14/20
SIMPLE	2/3, 2/3, 1/2, 1/2, 2/2, 1/1, 1/2, 1/3	13/20

COMMENTS:

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DISPLAY #: 2

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	0/3, 3/4, 1/2, 0/1, 0/2, 1/1, 2/2, 1/1	12/20
S & 5	3/3, 4/4, 1/2, 1/2, 2/2, 2/2, 2/2, 3/3	18/20
K & X	1/1, 1/2, 3/3, 2/2, 1/1, 3/3, 5/5, 2/4	17/20
U & V	1/2, 2/2, 1/2, 3/4, 3/4, 1/1, 2/2, 3/3	16/20
D & O	1/1, 0/2, 2/2, 1/3, 1/2, 0/1, 1/2, 3/4	9/20
SIMPLE	1/2, 1/1, 1/2, 1/3, 3/3, 3/4, 3/3, 2/2	15/20

COMMENTS:

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*** PERFORMANCE SHEET ***
****

Subject: NV

Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	0/1, 0/3, 1/1, 3/4, 0/3, 1/2, 1/2, 2/4	8/20
S & 5	4/4, 2/2, 2/2, 2/2, 3/3, 2/2, 2/3, 2/2	19/20
K & X	2/2, 3/3, 1/1, 1/1, 2/2, 4/4, 3/5, 2/2	18/20
U & V	1/4, 1/2, 0/4, 2/2, 1/2, 1/2, 1/3, 1/1	8/20
D & O	2/2, 3/3, 1/4, 1/3, 3/3, 1/3, 0/1, 1/1	12/20
SIMPLE	1/2, 2/3, 2/2, 1/2, 2/2, 3/4, 1/1, 3/3	15/20

DISPLAY #:3

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	1/2, 1/4, 0/3, 0/2, 2/4, 0/1, 1/3, 0/1	5/20
S & 5	3/4, 2/2, 1/2, 1/2, 3/3, 3/3, 2/2, 2/2	17/20
K & X	1/1, 4/5, 2/2, 2/2, 3/3, 1/1, 2/2, 4/4	19/20
U & V	0/2, 0/2, 2/4, 1/4, 1/2, 1/2, 2/3, 0/1	7/20
D & O	1/3, 1/3, 2/5, 2/3, 0/1, 0/1, 2/2, 1/4	9/20
SIMPLE	3/3, 2/2, 1/2, 3/3, 4/4, 1/1, 1/2, 3/3	18/20

DISPLAY #:1

COMMENTS:

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*** PERFORMANCE SHEET ***
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Subject: J.P.D

Date: ----------

DISPLAY #: 1

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	3/4, 2/3, 2/2, 1/4, [illegible], 0/3, 0/3, 0/1	8/20
S & 5	3/3, 4/4, 2/2, 2/2, 2/2, 3/3, 2/3, 2/2	20/20
K & X	1/3, 1/3, 5/5, 2/2, [illegible], 3/4, 4/4	19/20
U & V	1/1, 3/3, 1/2, 1/2, 1/3, 2/2, 2/2, 3/4	17/20
D & O	3/5, 3/3, 5/5, 1/1, 3/3, 1/1, 2/2, 2/4	18/20
SIMPLE	[illegible]	15/20

COMMENTS:

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DISPLAY #: 2

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & l	2/2, 2/3, 4/4, 1/1, 1/3, 2/3, 2/2, 3/4	15/20
S & 5	1/2, 3/4, 2/3, 2/2, 1/2, 2/2, 2/2, 3/3	16/20
K & X	2/2, 3/3, 1/1, 2/2, 3/4, 3/3, 3/5, 1/1	18/20
U & V	2/2, 1/1, 1/2, 3/4, 2/2, 3/4, 1/2, [illegible]	16/20
D & O	1/1, 1/3, 2/3, 1/2, 2/2, 3/3, 1/3, [illegible]	[illegible]
SIMPLE	1/2, 1/1, [illegible], 2/2, [illegible], 4/4, 3/4	18/20

COMMENTS:

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*** PERFORMANCE SHEET ***
****

Subject: JPD Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/1, 3/3, 1/1, 3/4, 0/3, 2/2, 2/2, 3/4	14/20
S & 5	4/4, 2/2, 2/2, 2/2, 3/3, 2/2, 3/3, 2/2	20/20
K & X	2/2, 3/3, 1/1, 1/1, 2/2, 3/4, 5/5, 2/2	19/20
U & V	0/4, 2/2, 1/4, 1/2, 0/2, 1/2, 3/3, 0/1	8/20
D & O	2/2, 2/3, 4/4, 2/3, 3/3, 2/3, 1/1, 0/1	16/20
SIMPLE	1/2, 2/3, 2/2, 2/2, 4/4, 1/1, 3/3, 2/3	17/20

DISPLAY #: 3

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/2, 1/4, 2/2, 0/1, 3/3, 0/1, 3/4, 0/3	9/20
S & 5	1/2, 1/2, 2/3, 2/2, 1/2, 2/2, 2/3, 2/4	13/20
K & X	2/2, 4/4, 4/5, 3/3, 2/2, 1/1, 2/2, 1/1	19/20
U & V	0/2, 3/3, 3/4, 0/2, 2/2, 3/4, 1/1, 1/2	13/20
D & O	3/4, 2/3, 0/1, 0/1, 2/2, 3/3, 2/3, 2/3	14/20
SIMPLE	1/1, 3/3, 3/3, 3/3, 2/2, 1/3, 1/2, 4/4	18/20

DISPLAY #: 4

COMMENTS:

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*** PERFORMANCE SHEET ***
****

Subject: DDG

Date: ----------

DISPLAY #: 1

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/4, 1/3, 0/3, 3/4, 0/1, 1/2, 2/2, 1/1	8/20
S & 5	3/3, 4/4, 2/2, 2/2, 2/2, 3/3, 2/2, 2/2	18/20
K & X	2/2, 1/1, 5/5, 2/2, 3/3, 1/1, 2/2, 4/4	20/20
U & V	1/1, 3/4, 1/2, 1/2, 3/3, 2/2, 2/2, 4/4	17/20
D & O	2/3, 1/3, 2/3, 1/1, 2/3, 0/1, 2/2, 1/4	11/20
SIMPLE	3/3, 3/3, 1/2, 2/2, 3/4, 1/1, 1/2, 2/3	16/20

COMMENTS:

DISPLAY #: 2

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	1/2, 3/4, 1/1, 2/3, 1/1, 2/2, 3/3, 3/4	16/20
S & 5	2/3, 1/2, 2/2, 2/2, 2/2, 3/3, 2/2, 4/4	18/20
K & X	3/3, 2/2, 4/5, 2/2, 4/4, 1/1, 2/2, 1/1	19/20
U & V	3/4, 1/1, 0/3, 2/4, 2/2, 2/2, 2/2, 3/3	15/20
D & O	0/1, 1/3, 2/3, 0/1, 0/2, 3/3, 1/3, 1/4	8/20
SIMPLE	2/2, 2/3, 1/1, 3/4, 1/2, 3/3, 2/3, 2/2	16/20

COMMENTS:

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*** PERFORMANCE SHEET ***
****

Subject: DDG1 Date:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/2, 0/4, 0/3, 1/2, 0/4, 0/1, 0/3, 0/1	1/20
S & 5	0/4, 0/2, 2/2, 1/2, 2/3, 0/3, 2/2, 2/2	9/20
K & X	1/1, 4/5, 1/2, 2/2, 2/3, 1/1, 2/2, 4/4	17/20
U & V	1/2, 0/2, 2/4, 2/4, 1/2, 2/2, 2/3, 0/1	10/20
D & O	1/3, 1/3, 1/3, 3/3, 0/1, 2/2, 3/4, 0/1	11/20
SIMPLE	2/3, 1/2, 1/2, 0/3, 2/4, 1/1, 1/2, 3/3	11/20

DISPLAY #:3

COMMENTS:

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/1, 0/3, 0/1, 4/4, 2/3, 1/2, 2/2, 3/4	11/20
S & 5	3/4, 2/2, 2/2, 1/2, 3/3, 2/2, 3/3, 1/2	17/20
K & X	2/2, 3/3, 1/1, 1/1, 2/2, 4/4, 4/5, 2/2	19/20
U & V	0/4, 2/2, 3/4, 1/2, 2/2, 2/2, 3/3, 1/1	14/20
D & O	2/2, 2/3, 3/4, 2/3, 3/3, 2/3, 0/1, 1/1	15/20
SIMPLE	1/2, 1/3, 1/2, 2/2, 3/3, 3/4, 1/1, 3/3	15/20

DISPLAY #:4

COMMENTS:

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*** PERFORMANCE SHEET ***
****

Subject: FJL Date:----------

DISPLAY #: 1

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0,0 ——————> 0	0/20
S & 5	0/2, 2/2, 2/3, 2/3, 2/2, 4/4, 2/2	16/20
K & X	2/2, 2/2, 3/3, 0/1, 5/5, 1/1, 2/2, 2/4	17/20
U & V	2/4, 1/1, 2/3, 2/4, 1/2, 2/2, 2/2, 2/2	14/20
D & O	1/1, 2/2, 1/1, 3/3, 2/3, 2/3, 3/4, 3/3	17/20
SIMPLE	3/3, 1/2, 4/4, 1/1, 2/2, 3/3, 1/3, 1/2	16/20

COMMENTS:

DISPLAY #: 2

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	3/3, 2/4, 1/2, 1/1, 2/3, 2/4, 2/2, 4/4	15/20
S & 5	2/3, 2/4, 2/2, 2/3, 2/3, 1/2, 2/2, 3/3	16/20
K & X	1/1, 2/2, 3/3, 2/2, 0/1, 2/2, 5/5, 4/4	19/20
U & V	1/2, 0/2, 1/2, 3/4, 2/4, 1/1, 2/2, 2/3	12/20
D & O	1/1, 0/3, 2/3, 2/3, 2/4, 0/1, 2/2, 2/3	11/20
SIMPLE	1/2, 1/1, 1/2, 2/3, 3/3, 3/4, 1/2, 1/2	13/20

COMMENTS:

****
*** PERFORMANCE SHEET ***
****

Subject: FJL Date:

DISPLAY #:3

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	2/2, 3/4, 2/3, 1/2, 2/4, 0/1, 2/3, 0/1	12/20
S & 5	4/4, 2/2, 2/2, 2/2, 2/3, 3/3, 2/2, 2/2	19/20
K & X	1/1, 4/5, 2/2, 2/2, 3/3, 1/1, 2/2, 4/4	19/20
U & V	1/2, 1/2, 1/4, 2/4, 2/2, 2/2, 3/3, 1/1	13/20
D & O	2/3, 2/3, 3/3, 3/3, 0/1, 1/1, 1/2, 3/4	15/20
SIMPLE	1/3, 1/2, 1/3, 2/4, 1/1, 2/2, 0/3, 1/2	9/20

COMMENTS:

DISPLAY #:4

TYPE OF ERROR	INDIVIDUAL SCORES	GRAND SCORE
I & 1	0/ , 0, 0, ——→ 0	0/20
S & 5	4/4, 1/2, 1/2, 2/2, 3/3, 1/2, 2/3, 1/2	14/20
K & X	2/2, 3/3, 1/1, 1/1, 2/2, 3/4, 5/5, 2/2	19/20
U & V	0/4, 2/2, 3/4, 2/2, 0/2, 0/2, 3/3, 0/1	10/20
D & O	1/2, 1/3, 2/4, 2/3, 1/3, 2/3, 0/1, 1/1	10/20
SIMPLE	0/2, 2/3, 2/2, 1/2, 3/4, 1/1, 3/5, 3/3	15/20

COMMENTS:

APPENDIX-C.2

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT AMC ---------- DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	39.6	42.6	39.5	42.2	41.2	39.5	41.1	41.8
2	42.4	40.7	41.9	38.6	39.3	41.5	41.7	44.2
3	40.8	39.2	39.8	37.9	39.2	40.3	41.6	42.1
4	41.6	40.8	39.3	39.4	37.9	41.7	39.4	38.3
5	41.5	41.2	40.7	38.0	40.8	43.4	42.6	41.2
6	41.3	40.4	39.6	38.5	39.0	39.8	38.4	38.2

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT PAC DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	38.3	36.4	41.1	36.1	38.5	39.0	39.2	40.6
2	35.8	36.8	38.7	37.4	40.0	39.6	40.7	39.8
3	36.6	36.0	37.9	37.0	38.0	37.6	38.9	39.6
4	36.0	38.1	38.6	36.6	36.7	38.7	39.7	38.5
5	37.3	35.9	38.1	36.2	36.8	38.1	39.5	37.5
6	36.4	35.4	37.8	36.9	37.8	39.7	38.9	38.2

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT T.K.J ----------

DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	36.5	34.8	37.7	34.7	43.4	34.5	36.7	35.6
2	34.3	34.8	36.1	33.7	39.2	34.7	35.1	33.6
3	35.1	34.0	36.0	34.2	36.8	35.6	35.0	33.5
4	34.7	33.2	34.8	33.0	34.9	34.4	35.3	32.9
5	34.1	33.3	34.9	33.1	36.2	35.4	34.2	34.5
6	34.4	34.7	32.4	30.7	34.5	33.3	34.6	32.1

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT JSS

DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	32.8	30.1	34.8	31.0	34.6	31.3	34.0	35.1
2	31.9	30.5	34.3	29.3	31.7	32.7	33.1	32.8
3	30.8	29.6	33.9	29.5	30.0	32.5	32.8	32.9
4	30.6	29.8	33.0	28.9	28.2	32.1	32.5	32.4
5	30.6	30.4	32.8	26.8	28.2	32.1	32.2	32.7
6	30.5	29.7	32.7	26.8	29.8	29.9	31.5	32.3

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT GMS ---------- DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	33.3	33.0	35.7	36.4	34.8	32.3	33.2	32.0
2	31.9	35.4	35.0	35.5	36.7	35.1	34.1	31.5
3	32.9	33.2	35.6	34.9	36.9	33.7	33.6	32.1
4	33.7	33.1	34.7	36.0	35.0	33.1	33.5	32.4
5	33.0	33.8	35.5	36.1	34.6	34.5	33.1	34.0
6	32.8	33.2	37.2	35.7	33.6	33.2	33.6	34.5

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT FZP ---------- DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	36.8	37.2	35.1	34.2	35.0	35.4	37.0	32.5
2	36.6	38.8	34.9	33.1	33.4	36.4	36.2	34.1
3	36.2	34.4	33.1	33.3	36.0	35.4	35.7	32.8
4	35.9	33.4	33.9	34.8	36.4	35.6	34.7	35.5
5	37.4	35.9	33.8	34.2	36.6	37.4	36.0	35.4
6	35.8	35.0	33.8	33.4	36.8	36.5	36.1	37.2

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT MV DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	43.6	37.5	37.8	39.3	41.2	38.3	36.8	38.9
2	39.3	36.3	37.3	38.3	41.3	39.1	39.4	38.9
3	39.2	36.2	36.9	39.1	39.2	37.1	38.6	37.1
4	37.4	34.9	38.1	36.4	39.5	37.7	37.4	36.6
5	34.5	34.6	37.0	34.3	38.4	34.9	36.2	36.4
6	35.7	36.5	38.7	35.1	38.8	34.6	37.3	34.1

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT JPD

DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	33.1	33.1	34.6	31.8	35.0	32.1	33.8	31.6
2	33.7	33.9	32.7	32.3	35.3	32.4	34.5	32.5
3	32.1	33.5	33.0	35.1	32.8	32.7	33.5	33.6
4	33.1	32.4	30.9	33.2	31.6	31.4	32.6	31.0
5	33.9	30.2	32.6	33.4	34.2	29.9	32.7	32.3
6	32.2	31.9	31.9	32.4	32.0	29.9	32.5	31.6

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT DDG J DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	34.6	34.3	36.8	34.2	35.9	33.5	34.5	31.9
2	33.9	35.3	35.7	33.1	33.0	34.2	34.5	34.4
3	33.0	33.1	34.6	32.5	33.0	32.1	34.3	33.8
4	33.2	31.8	35.4	32.0	32.4	32.5	34.1	31.9
5	33.4	30.9	34.1	30.7	31.0	30.2	34.0	32.3
6	33.7	32.6	35.1	31.5	31.6	29.6	35.5	31.8

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

****
*** CRITICAL FUSION FREQUENCY ***
****

SUBJECT FJL DATE: ----------

TRIAL #	DISPLAY #1		DISPLAY #2		DISPLAY #3		DISPLAY #4	
	BEF	AFT	BEF	AFT	BEF	AFT	BEF	AFT
1	35.2	36.2	34.7	35.6	37.2	35.7	32.5	39.1
2	34.1	32.6	33.2	35.2	35.6	34.5	34.2	32.5
3	32.5	33.6	31.5	32.8	33.4	33.8	32.6	32.5
4	32.3	33.1	31.1	33.5	36.4	34.6	33.0	33.7
5	31.9	31.7	31.5	32.9	34.1	33.6	34.0	31.9
6	32.5	30.9	31.3	34.2	35.6	34.3	33.3	33.2

KEY:

DISPLAY #1 : PAPER

#2 : VT-52 (DIGITAL)

#3 : TV-910 (-ve Pol.) Light characters on dark background.

#4 : TV-910 (+ve Pol.) Dark characters on light background.

APPENDIX-D.1

Subject: FZP

	% correct detected	
Period	Positive polarity	Negative polarity
1	69.2	77.6
2	68.1	65.9
3	74.4	64.9
4	70.6	60.0

Subject: FJL

	% correct detected	
Period	Positive polarity	Negative polarity
1	93.5	83.7
2	90.2	78.8
3	88.2	73.1
4	83.3	75.4

Subject: DEU

Period	% correct detected	
	Positive polarity	Negative polarity
1	88.1	88.1
2	88.3	76.2
3	84.8	82.9
4	77.4	68.9

Subject: JSS

Period	% correct detected	
	Positive polarity	Negative polarity
1	91.2	80.0
2	81.8	82.1
3	66.0	76.4
4	67.9	84.9

Subject: JPD

	% correct detected	
Period	Positive polarity	Negative polarity
1	75.0	80.8
2	75.4	66.7
3	65.4	67.3
4	80.8	67.9

Subject: KAO

	% correct detected	
Period	Positive polarity	Negative polarity
1	70.0	92.0
2	75.0	75.0
3	60.5	73.7
4	51.4	82.2

Subject: ANS

Period	% correct detected	
	Positive polarity	Negative polarity
1	85.1	82.0
2	64.8	68.4
3	61.9	79.6
4	71.1	83.3

Subject: NIV

Period	% correct detected	
	Positive polarity	Negative polarity
1	80.8	83.3
2	82.8	84.9
3	62.3	80.7
4	57.6	67.4

Subject: TKJ

	% correct detected	
Period	Positive polarity	Negative polarity
1	75.3	74.6
2	70.2	60.0
3	73.2	56.1
4	75.3	64.6

Subject: GMS

	% correct detected	
Period	Positive polarity	Negative polarity
1	86.4	79.4
2	80.8	71.2
3	68.9	64.4
4	90.9	73.9

APPENDIX-D.2

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**************************************************
********   FILE NAME IS: **  KAQ03.DAT  **********
**************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:       524
*** NUMBER OF POSITIVE POINTS IS:       471
*** SUM OF HR"S, WHEN DECREASING:     16991
*** NUMBER OF RELATIVE MAXIMA IS:       285
*** NUMBER OF RELATIVE MINIMA IS:       285
*** NUMBER OF BEATS IS :                995
*** SCORE IS :                       2.98088
*** NUMBER OF BLINKS IS:                 70
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:       499
*** NUMBER OF POSITIVE POINTS IS:       517
*** SUM OF HR"S, WHEN DECREASING:     20062
*** NUMBER OF RELATIVE MAXIMA IS:       245
*** NUMBER OF RELATIVE MINIMA IS:       246
*** NUMBER OF BEATS IS :               1016
*** SCORE IS :                       4.08595
*** NUMBER OF BLINKS IS:                101
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:       496
*** NUMBER OF POSITIVE POINTS IS:       507
*** SUM OF HR"S, WHEN DECREASING:     19227
*** NUMBER OF RELATIVE MAXIMA IS:       266
*** NUMBER OF RELATIVE MINIMA IS:       266
*** NUMBER OF BEATS IS :               1003
*** SCORE IS :                       3.61410
*** NUMBER OF BLINKS IS:                 91
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:       447
*** NUMBER OF POSITIVE POINTS IS:       528
*** SUM OF HR"S, WHEN DECREASING:     21865
*** NUMBER OF RELATIVE MAXIMA IS:       234
*** NUMBER OF RELATIVE MINIMA IS:       233
*** NUMBER OF BEATS IS :                975
*** SCORE IS :                       4.68201
*** NUMBER OF BLINKS IS:                 96
**************************************************
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****
******** FILE NAME IS: ** KAQ04.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 509
*** NUMBER OF POSITIVE POINTS IS: 517
*** SUM OF HR"S, WHEN DECREASING: 17582
*** NUMBER OF RELATIVE MAXIMA IS: 315
*** NUMBER OF RELATIVE MINIMA IS: 315
*** NUMBER OF BEATS IS : 1026
*** SCORE IS : 2.79079
*** NUMBER OF BLINKS IS: 139
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 490
*** NUMBER OF POSITIVE POINTS IS: 504
*** SUM OF HR"S, WHEN DECREASING: 25002
*** NUMBER OF RELATIVE MAXIMA IS: 299
*** NUMBER OF RELATIVE MINIMA IS: 300
*** NUMBER OF BEATS IS : 994
*** SCORE IS : 4.17396
*** NUMBER OF BLINKS IS: 108
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 472
*** NUMBER OF POSITIVE POINTS IS: 525
*** SUM OF HR"S, WHEN DECREASING: 19019
*** NUMBER OF RELATIVE MAXIMA IS: 295
*** NUMBER OF RELATIVE MINIMA IS: 295
*** NUMBER OF BEATS IS : 997
*** SCORE IS : 3.22356
*** NUMBER OF BLINKS IS: 109
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 446
*** NUMBER OF POSITIVE POINTS IS: 486
*** SUM OF HR"S, WHEN DECREASING: 17456
*** NUMBER OF RELATIVE MAXIMA IS: 282
*** NUMBER OF RELATIVE MINIMA IS: 281
*** NUMBER OF BEATS IS : 932
*** SCORE IS : 3.10053
*** NUMBER OF BLINKS IS: 103
****

****
******** FILE NAME IS: ** FJL03.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 401
*** NUMBER OF POSITIVE POINTS IS: 451
*** SUM OF HR"S, WHEN DECREASING: 15182
*** NUMBER OF RELATIVE MAXIMA IS: 221
*** NUMBER OF RELATIVE MINIMA IS: 222
*** NUMBER OF BEATS IS : 852
*** SCORE IS : 3.42709
*** NUMBER OF BLINKS IS: 167
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 294
*** NUMBER OF POSITIVE POINTS IS: 326
*** SUM OF HR"S, WHEN DECREASING: 8456
*** NUMBER OF RELATIVE MAXIMA IS: 133
*** NUMBER OF RELATIVE MINIMA IS: 132
*** NUMBER OF BEATS IS : 620
*** SCORE IS : 3.19094
*** NUMBER OF BLINKS IS: 137
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 275
*** NUMBER OF POSITIVE POINTS IS: 344
*** SUM OF HR"S, WHEN DECREASING: 10329
*** NUMBER OF RELATIVE MAXIMA IS: 122
*** NUMBER OF RELATIVE MINIMA IS: 123
*** NUMBER OF BEATS IS : 619
*** SCORE IS : 4.21592
*** NUMBER OF BLINKS IS: 144
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 337
*** NUMBER OF POSITIVE POINTS IS: 457
*** SUM OF HR"S, WHEN DECREASING: 16126
*** NUMBER OF RELATIVE MAXIMA IS: 189
*** NUMBER OF RELATIVE MINIMA IS: 188
*** NUMBER OF BEATS IS : 794
*** SCORE IS : 4.27745
*** NUMBER OF BLINKS IS: 138
****

****
******** FILE NAME IS: ** FJL04.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 469
*** NUMBER OF POSITIVE POINTS IS: 432
*** SUM OF HR"S, WHEN DECREASING: 8763
*** NUMBER OF RELATIVE MAXIMA IS: 225
*** NUMBER OF RELATIVE MINIMA IS: 225
*** NUMBER OF BEATS IS : 901
*** SCORE IS : 1.94733
*** NUMBER OF BLINKS IS: 124
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 430
*** NUMBER OF POSITIVE POINTS IS: 435
*** SUM OF HR"S, WHEN DECREASING: 8460
*** NUMBER OF RELATIVE MAXIMA IS: 194
*** NUMBER OF RELATIVE MINIMA IS: 194
*** NUMBER OF BEATS IS : 865
*** SCORE IS : 2.18041
*** NUMBER OF BLINKS IS: 109
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 449
*** NUMBER OF POSITIVE POINTS IS: 407
*** SUM OF HR"S, WHEN DECREASING: 7496
*** NUMBER OF RELATIVE MAXIMA IS: 194
*** NUMBER OF RELATIVE MINIMA IS: 194
*** NUMBER OF BEATS IS : 856
*** SCORE IS : 1.93196
*** NUMBER OF BLINKS IS: 102
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 393
*** NUMBER OF POSITIVE POINTS IS: 369
*** SUM OF HR"S, WHEN DECREASING: 6885
*** NUMBER OF RELATIVE MAXIMA IS: 167
*** NUMBER OF RELATIVE MINIMA IS: 168
*** NUMBER OF BEATS IS : 762
*** SCORE IS : 2.05522
*** NUMBER OF BLINKS IS: 105
****

****
******** FILE NAME IS: ** TKJ03.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 667
*** NUMBER OF POSITIVE POINTS IS: 494
*** SUM OF HR"S, WHEN DECREASING: 18482
*** NUMBER OF RELATIVE MAXIMA IS: 270
*** NUMBER OF RELATIVE MINIMA IS: 271
*** NUMBER OF BEATS IS : 1161
*** SCORE IS : 3.41627
*** NUMBER OF BLINKS IS: 131
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 643
*** NUMBER OF POSITIVE POINTS IS: 488
*** SUM OF HR"S, WHEN DECREASING: 16661
*** NUMBER OF RELATIVE MAXIMA IS: 272
*** NUMBER OF RELATIVE MINIMA IS: 272
*** NUMBER OF BEATS IS : 1131
*** SCORE IS : 3.06268
*** NUMBER OF BLINKS IS: 132
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 610
*** NUMBER OF POSITIVE POINTS IS: 472
*** SUM OF HR"S, WHEN DECREASING: 15980
*** NUMBER OF RELATIVE MAXIMA IS: 267
*** NUMBER OF RELATIVE MINIMA IS: 267
*** NUMBER OF BEATS IS : 1082
*** SCORE IS : 2.99251
*** NUMBER OF BLINKS IS: 186
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 573
*** NUMBER OF POSITIVE POINTS IS: 454
*** SUM OF HR"S, WHEN DECREASING: 14638
*** NUMBER OF RELATIVE MAXIMA IS: 262
*** NUMBER OF RELATIVE MINIMA IS: 262
*** NUMBER OF BEATS IS : 1027
*** SCORE IS : 2.79351
*** NUMBER OF BLINKS IS: 121
****

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**************************************************
********    FILE NAME IS: **  TKJ04.DAT  **********
**************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:        657
*** NUMBER OF POSITIVE POINTS IS:        532
*** SUM OF HR"S, WHEN DECREASING:      18100
*** NUMBER OF RELATIVE MAXIMA IS:        275
*** NUMBER OF RELATIVE MINIMA IS:        276
*** NUMBER OF BEATS IS :                1189
*** SCORE IS :                        3.28494
*** NUMBER OF BLINKS IS:                 199
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:        624
*** NUMBER OF POSITIVE POINTS IS:        551
*** SUM OF HR"S, WHEN DECREASING:      17813
*** NUMBER OF RELATIVE MAXIMA IS:        267
*** NUMBER OF RELATIVE MINIMA IS:        267
*** NUMBER OF BEATS IS :                1175
*** SCORE IS :                        3.33577
*** NUMBER OF BLINKS IS:                 143
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:        637
*** NUMBER OF POSITIVE POINTS IS:        561
*** SUM OF HR"S, WHEN DECREASING:      18872
*** NUMBER OF RELATIVE MAXIMA IS:        267
*** NUMBER OF RELATIVE MINIMA IS:        267
*** NUMBER OF BEATS IS :                1198
*** SCORE IS :                        3.53408
*** NUMBER OF BLINKS IS:                 176
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:        582
*** NUMBER OF POSITIVE POINTS IS:        543
*** SUM OF HR"S, WHEN DECREASING:      16939
*** NUMBER OF RELATIVE MAXIMA IS:        250
*** NUMBER OF RELATIVE MINIMA IS:        250
*** NUMBER OF BEATS IS :                1125
*** SCORE IS :                        3.38780
*** NUMBER OF BLINKS IS:                 169
**************************************************
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****
******** FILE NAME IS: ** ANS03.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 644
*** NUMBER OF POSITIVE POINTS IS: 478
*** SUM OF HR"S, WHEN DECREASING: 15342
*** NUMBER OF RELATIVE MAXIMA IS: 219
*** NUMBER OF RELATIVE MINIMA IS: 219
*** NUMBER OF BEATS IS : 1122
*** SCORE IS : 3.50274
*** NUMBER OF BLINKS IS: —
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 607
*** NUMBER OF POSITIVE POINTS IS: 539
*** SUM OF HR"S, WHEN DECREASING: 14430
*** NUMBER OF RELATIVE MAXIMA IS: 193
*** NUMBER OF RELATIVE MINIMA IS: 193
*** NUMBER OF BEATS IS : 1146
*** SCORE IS : 3.73834
*** NUMBER OF BLINKS IS: —
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 603
*** NUMBER OF POSITIVE POINTS IS: 477
*** SUM OF HR"S, WHEN DECREASING: 14823
*** NUMBER OF RELATIVE MAXIMA IS: 217
*** NUMBER OF RELATIVE MINIMA IS: 218
*** NUMBER OF BEATS IS : 1080
*** SCORE IS. : 3.40759
*** NUMBER OF BLINKS IS: —
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 613
*** NUMBER OF POSITIVE POINTS IS: 481
*** SUM OF HR"S, WHEN DECREASING: 14948
*** NUMBER OF RELATIVE MAXIMA IS: 231
*** NUMBER OF RELATIVE MINIMA IS: 230
*** NUMBER OF BEATS IS : 1094
*** SCORE IS : 3.24252
*** NUMBER OF BLINKS IS: —
****

****
******** FILE NAME IS: ** ANS04.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 539
*** NUMBER OF POSITIVE POINTS IS: 398
*** SUM OF HR"S, WHEN DECREASING: 12244
*** NUMBER OF RELATIVE MAXIMA IS: 208
*** NUMBER OF RELATIVE MINIMA IS: 208
*** NUMBER OF BEATS IS : 937
*** SCORE IS : 2.94327
*** NUMBER OF BLINKS IS:
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 551
*** NUMBER OF POSITIVE POINTS IS: 400
*** SUM OF HR"S, WHEN DECREASING: 14489
*** NUMBER OF RELATIVE MAXIMA IS: 220
*** NUMBER OF RELATIVE MINIMA IS: 221
*** NUMBER OF BEATS IS : 951
*** SCORE IS : 3.28549
*** NUMBER OF BLINKS IS:
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 472
*** NUMBER OF POSITIVE POINTS IS: 402
*** SUM OF HR"S, WHEN DECREASING: 14101
*** NUMBER OF RELATIVE MAXIMA IS: 200
*** NUMBER OF RELATIVE MINIMA IS: 199
*** NUMBER OF BEATS IS : 874
*** SCORE IS : 3.53409
*** NUMBER OF BLINKS IS:
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 530
*** NUMBER OF POSITIVE POINTS IS: 419
*** SUM OF HR"S, WHEN DECREASING: 22856
*** NUMBER OF RELATIVE MAXIMA IS: 216
*** NUMBER OF RELATIVE MINIMA IS: 217
*** NUMBER OF BEATS IS : 949
*** SCORE IS : 5.27852
*** NUMBER OF BLINKS IS:
****

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**************************************************
********   FILE NAME IS: **  DEU03.DAT  **********
**************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:       582
*** NUMBER OF POSITIVE POINTS IS:       481
*** SUM OF HR"S, WHEN DECREASING:     11622
*** NUMBER OF RELATIVE MAXIMA IS:       200
*** NUMBER OF RELATIVE MINIMA IS:       201
*** NUMBER OF BEATS IS :               1063
*** SCORE IS :                        2.89825
*** NUMBER OF BLINKS IS:                 60
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:       577
*** NUMBER OF POSITIVE POINTS IS:       487
*** SUM OF HR"S, WHEN DECREASING:     11774
*** NUMBER OF RELATIVE MAXIMA IS:       197
*** NUMBER OF RELATIVE MINIMA IS:       197
*** NUMBER OF BEATS IS :               1064
*** SCORE IS :                        2.98832
*** NUMBER OF BLINKS IS:                 76
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:       570
*** NUMBER OF POSITIVE POINTS IS:       463
*** SUM OF HR"S, WHEN DECREASING:     11838
*** NUMBER OF RELATIVE MAXIMA IS:       207
*** NUMBER OF RELATIVE MINIMA IS:       206
*** NUMBER OF BEATS IS :               1033
*** SCORE IS :                        2.86634
*** NUMBER OF BLINKS IS:                 78
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:       575
*** NUMBER OF POSITIVE POINTS IS:       489
*** SUM OF HR"S, WHEN DECREASING:     12740
*** NUMBER OF RELATIVE MAXIMA IS:       207
*** NUMBER OF RELATIVE MINIMA IS:       208
*** NUMBER OF BEATS IS :               1064
*** SCORE IS :                        3.06988
*** NUMBER OF BLINKS IS:                 98
**************************************************
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****
******** FILE NAME IS: ** DEU04.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 516
*** NUMBER OF POSITIVE POINTS IS: 504
*** SUM OF HR"S, WHEN DECREASING: 32375
*** NUMBER OF RELATIVE MAXIMA IS: 215
*** NUMBER OF RELATIVE MINIMA IS: 216
*** NUMBER OF BEATS IS : 1020
*** SCORE IS : 7.51160
*** NUMBER OF BLINKS IS: 72
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 517
*** NUMBER OF POSITIVE POINTS IS: 468
*** SUM OF HR"S, WHEN DECREASING: 17344
*** NUMBER OF RELATIVE MAXIMA IS: 213
*** NUMBER OF RELATIVE MINIMA IS: 213
*** NUMBER OF BEATS IS : 985
*** SCORE IS : 4.07136
*** NUMBER OF BLINKS IS: 44
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 529
*** NUMBER OF POSITIVE POINTS IS: 477
*** SUM OF HR"S, WHEN DECREASING: 17141
*** NUMBER OF RELATIVE MAXIMA IS: 212
*** NUMBER OF RELATIVE MINIMA IS: 211
*** NUMBER OF BEATS IS : 1006
*** SCORE IS : 4.05225
*** NUMBER OF BLINKS IS: 59
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 494
*** NUMBER OF POSITIVE POINTS IS: 495
*** SUM OF HR"S, WHEN DECREASING: 17489
*** NUMBER OF RELATIVE MAXIMA IS: 196
*** NUMBER OF RELATIVE MINIMA IS: 196
*** NUMBER OF BEATS IS : 989
*** SCORE IS : 4.46148
*** NUMBER OF BLINKS IS: 66
****

****
******** FILE NAME IS: ** FZP03.DAT **********
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**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 505
*** NUMBER OF POSITIVE POINTS IS: 474
*** SUM OF HR"S, WHEN DECREASING: 20436
*** NUMBER OF RELATIVE MAXIMA IS: 229
*** NUMBER OF RELATIVE MINIMA IS: 230
*** NUMBER OF BEATS IS : 979
*** SCORE IS : 4.45229
*** NUMBER OF BLINKS IS: 36
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 470
*** NUMBER OF POSITIVE POINTS IS: 528
*** SUM OF HR"S, WHEN DECREASING: 22482
*** NUMBER OF RELATIVE MAXIMA IS: 207
*** NUMBER OF RELATIVE MINIMA IS: 206
*** NUMBER OF BEATS IS : 998
*** SCORE IS : 5.44358
*** NUMBER OF BLINKS IS: 70
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 482
*** NUMBER OF POSITIVE POINTS IS: 489
*** SUM OF HR"S, WHEN DECREASING: 20671
*** NUMBER OF RELATIVE MAXIMA IS: 217
*** NUMBER OF RELATIVE MINIMA IS: 218
*** NUMBER OF BEATS IS : 971
*** SCORE IS : 4.75195
*** NUMBER OF BLINKS IS: 74
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 470
*** NUMBER OF POSITIVE POINTS IS: 481
*** SUM OF HR"S, WHEN DECREASING: 22470
*** NUMBER OF RELATIVE MAXIMA IS: 213
*** NUMBER OF RELATIVE MINIMA IS: 213
*** NUMBER OF BEATS IS : 951
*** SCORE IS : 5.27465
*** NUMBER OF BLINKS IS: 57
****

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**************************************************
********   FILE NAME IS: **  FZP04.DAT  **********
**************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:      456
*** NUMBER OF POSITIVE POINTS IS:      471
*** SUM OF HR"S, WHEN DECREASING:    16162
*** NUMBER OF RELATIVE MAXIMA IS:      237
*** NUMBER OF RELATIVE MINIMA IS:      238
*** NUMBER OF BEATS IS :               927
*** SCORE IS :                      3.40253
*** NUMBER OF BLINKS IS:                69
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:      461
*** NUMBER OF POSITIVE POINTS IS:      453
*** SUM OF HR"S, WHEN DECREASING:    16812
*** NUMBER OF RELATIVE MAXIMA IS:      226
*** NUMBER OF RELATIVE MINIMA IS:      225
*** NUMBER OF BEATS IS :               914
*** SCORE IS :                      3.72772
*** NUMBER OF BLINKS IS:                58
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:      465
*** NUMBER OF POSITIVE POINTS IS:      465
*** SUM OF HR"S, WHEN DECREASING:    18478
*** NUMBER OF RELATIVE MAXIMA IS:      233
*** NUMBER OF RELATIVE MINIMA IS:      233
*** NUMBER OF BEATS IS :               930
*** SCORE IS :                      3.96524
*** NUMBER OF BLINKS IS:                33
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:      471
*** NUMBER OF POSITIVE POINTS IS:      457
*** SUM OF HR"S, WHEN DECREASING:    18924
*** NUMBER OF RELATIVE MAXIMA IS:      237
*** NUMBER OF RELATIVE MINIMA IS:      237
*** NUMBER OF BEATS IS :               928
*** SCORE IS :                      3.99241
*** NUMBER OF BLINKS IS:                32
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**************************************************
********    FILE NAME IS: **  GMS04.DAT  **********
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**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:        505
*** NUMBER OF POSITIVE POINTS IS:        373
*** SUM OF HR"S, WHEN DECREASING:      18270
*** NUMBER OF RELATIVE MAXIMA IS:        255
*** NUMBER OF RELATIVE MINIMA IS:        254
*** NUMBER OF BEATS IS :                 877
*** SCORE IS :                        3.58939
*** NUMBER OF BLINKS IS:                  45
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:        506
*** NUMBER OF POSITIVE POINTS IS:        380
*** SUM OF HR"S, WHEN DECREASING:      17074
*** NUMBER OF RELATIVE MAXIMA IS:        241
*** NUMBER OF RELATIVE MINIMA IS:        242
*** NUMBER OF BEATS IS :                 886
*** SCORE IS :                        3.53499
*** NUMBER OF BLINKS IS:                  28
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:        520
*** NUMBER OF POSITIVE POINTS IS:        349
*** SUM OF HR"S, WHEN DECREASING:      17067
*** NUMBER OF RELATIVE MAXIMA IS:        228
*** NUMBER OF RELATIVE MINIMA IS:        227
*** NUMBER OF BEATS IS :                 869
*** SCORE IS :                        3.75099
*** NUMBER OF BLINKS IS:                  37
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:        503
*** NUMBER OF POSITIVE POINTS IS:        380
*** SUM OF HR"S, WHEN DECREASING:      15587
*** NUMBER OF RELATIVE MAXIMA IS:        232
*** NUMBER OF RELATIVE MINIMA IS:        233
*** NUMBER OF BEATS IS :                 883
*** SCORE IS :                        3.35204
*** NUMBER OF BLINKS IS:                  39
**************************************************
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**************************************************
********    FILE NAME IS: **  JSS03.DAT  **********
**************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:       582
*** NUMBER OF POSITIVE POINTS IS:       430
*** SUM OF HR"S, WHEN DECREASING:      9666
*** NUMBER OF RELATIVE MAXIMA IS:       253
*** NUMBER OF RELATIVE MINIMA IS:       254
*** NUMBER OF BEATS IS :               1012
*** SCORE IS :                       1.90651
*** NUMBER OF BLINKS IS:                 71
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:       568
*** NUMBER OF POSITIVE POINTS IS:       428
*** SUM OF HR"S, WHEN DECREASING:      9789
*** NUMBER OF RELATIVE MAXIMA IS:       257
*** NUMBER OF RELATIVE MINIMA IS:       257
*** NUMBER OF BEATS IS :                996
*** SCORE IS :                       1.90447
*** NUMBER OF BLINKS IS:                 63
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:       527
*** NUMBER OF POSITIVE POINTS IS:       449
*** SUM OF HR"S, WHEN DECREASING:      8776
*** NUMBER OF RELATIVE MAXIMA IS:       224
*** NUMBER OF RELATIVE MINIMA IS:       223
*** NUMBER OF BEATS IS :                976
*** SCORE IS :                       1.96331
*** NUMBER OF BLINKS IS:                 66
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:       571
*** NUMBER OF POSITIVE POINTS IS:       419
*** SUM OF HR"S, WHEN DECREASING:     11399
*** NUMBER OF RELATIVE MAXIMA IS:       232
*** NUMBER OF RELATIVE MINIMA IS:       232
*** NUMBER OF BEATS IS :                990
*** SCORE IS :                       2.45668
*** NUMBER OF BLINKS IS:                 97
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**********************************************************
********   FILE NAME IS: **  KSS04.DAT  **********
**********************************************************


**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:       440
*** NUMBER OF POSITIVE POINTS IS:       363
*** SUM OF HR"S, WHEN DECREASING:      8233
*** NUMBER OF RELATIVE MAXIMA IS:       228
*** NUMBER OF RELATIVE MINIMA IS:       227
*** NUMBER OF BEATS IS :                802
*** SCORE IS :                       1.80945
*** NUMBER OF BLINKS IS:                102
**********************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:       421
*** NUMBER OF POSITIVE POINTS IS:       341
*** SUM OF HR"S, WHEN DECREASING:      7469
*** NUMBER OF RELATIVE MAXIMA IS:       201
*** NUMBER OF RELATIVE MINIMA IS:       201
*** NUMBER OF BEATS IS :                762
*** SCORE IS :                       1.85796
*** NUMBER OF BLINKS IS:                123
**********************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:       454
*** NUMBER OF POSITIVE POINTS IS:       344
*** SUM OF HR"S, WHEN DECREASING:      9168
*** NUMBER OF RELATIVE MAXIMA IS:       216
*** NUMBER OF RELATIVE MINIMA IS:       217
*** NUMBER OF BEATS IS :                798
*** SCORE IS :                       2.11732
*** NUMBER OF BLINKS IS:                 96
**********************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:       443
*** NUMBER OF POSITIVE POINTS IS:       376
*** SUM OF HR"S, WHEN DECREASING:      9099
*** NUMBER OF RELATIVE MAXIMA IS:       199
*** NUMBER OF RELATIVE MINIMA IS:       198
*** NUMBER OF BEATS IS :                819
*** SCORE IS :                       2.29194
*** NUMBER OF BLINKS IS:                125
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********    FILE NAME IS: **  JPD03.DAT  **********
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**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:      559
*** NUMBER OF POSITIVE POINTS IS:      510
*** SUM OF HR"S, WHEN DECREASING:    12508
*** NUMBER OF RELATIVE MAXIMA IS:      213
*** NUMBER OF RELATIVE MINIMA IS:      212
*** NUMBER OF BEATS IS :              1068
*** SCORE IS :                      2.94306
*** NUMBER OF BLINKS IS:                64
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:      573
*** NUMBER OF POSITIVE POINTS IS:      536
*** SUM OF HR"S, WHEN DECREASING:    14605
*** NUMBER OF RELATIVE MAXIMA IS:      203
*** NUMBER OF RELATIVE MINIMA IS:      204
*** NUMBER OF BEATS IS :              1109
*** SCORE IS :                      3.58845
*** NUMBER OF BLINKS IS:                81
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:      559
*** NUMBER OF POSITIVE POINTS IS:      504
*** SUM OF HR"S, WHEN DECREASING:    14459
*** NUMBER OF RELATIVE MAXIMA IS:      194
*** NUMBER OF RELATIVE MINIMA IS:      193
*** NUMBER OF BEATS IS :              1063
*** SCORE IS :                      3.73618
*** NUMBER OF BLINKS IS:                82
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:      562
*** NUMBER OF POSITIVE POINTS IS:      520
*** SUM OF HR"S, WHEN DECREASING:    14623
*** NUMBER OF RELATIVE MAXIMA IS:      188
*** NUMBER OF RELATIVE MINIMA IS:      189
*** NUMBER OF BEATS IS :              1082
*** SCORE IS :                      3.87878
*** NUMBER OF BLINKS IS:                110
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******** FILE NAME IS: ** JPD04.DAT **********
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**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 604
*** NUMBER OF POSITIVE POINTS IS: 459
*** SUM OF HR"S, WHEN DECREASING: 16646
*** NUMBER OF RELATIVE MAXIMA IS: 220
*** NUMBER OF RELATIVE MINIMA IS: 221
*** NUMBER OF BEATS IS : 1063
*** SCORE IS : 3.77460
*** NUMBER OF BLINKS IS: 97
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 581
*** NUMBER OF POSITIVE POINTS IS: 458
*** SUM OF HR"S, WHEN DECREASING: 16972
*** NUMBER OF RELATIVE MAXIMA IS: 206
*** NUMBER OF RELATIVE MINIMA IS: 205
*** NUMBER OF BEATS IS : 1039
*** SCORE IS : 4.12944
*** NUMBER OF BLINKS IS: 107
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 583
*** NUMBER OF POSITIVE POINTS IS: 462
*** SUM OF HR"S, WHEN DECREASING: 14865
*** NUMBER OF RELATIVE MAXIMA IS: 193
*** NUMBER OF RELATIVE MINIMA IS: 194
*** NUMBER OF BEATS IS : 1045
*** SCORE IS : 3.84109
*** NUMBER OF BLINKS IS: 108
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 567
*** NUMBER OF POSITIVE POINTS IS: 473
*** SUM OF HR"S, WHEN DECREASING: 16000
*** NUMBER OF RELATIVE MAXIMA IS: 195
*** NUMBER OF RELATIVE MINIMA IS: 195
*** NUMBER OF BEATS IS : 1040
*** SCORE IS : 4.10256
*** NUMBER OF BLINKS IS: 157
****

****
******** FILE NAME IS: ** NIV03.DAT **********
****

**** PERIOD IS: 1
****

*** NUMBER OF NEGATIVE POINTS IS: 527
*** NUMBER OF POSITIVE POINTS IS: 466
*** SUM OF HR"S, WHEN DECREASING: 8905
*** NUMBER OF RELATIVE MAXIMA IS: 262
*** NUMBER OF RELATIVE MINIMA IS: 263
*** NUMBER OF BEATS IS : 993
*** SCORE IS : 1.69619
*** NUMBER OF BLINKS IS: 109
****

**** PERIOD IS: 2
****

*** NUMBER OF NEGATIVE POINTS IS: 539
*** NUMBER OF POSITIVE POINTS IS: 493
*** SUM OF HR"S, WHEN DECREASING: 10817
*** NUMBER OF RELATIVE MAXIMA IS: 254
*** NUMBER OF RELATIVE MINIMA IS: 253
*** NUMBER OF BEATS IS : 1032
*** SCORE IS : 2.13353
*** NUMBER OF BLINKS IS: 100
****

**** PERIOD IS: 3
****

*** NUMBER OF NEGATIVE POINTS IS: 527
*** NUMBER OF POSITIVE POINTS IS: 494
*** SUM OF HR"S, WHEN DECREASING: 10028
*** NUMBER OF RELATIVE MAXIMA IS: 249
*** NUMBER OF RELATIVE MINIMA IS: 249
*** NUMBER OF BEATS IS : 1021
*** SCORE IS : 2.01365
*** NUMBER OF BLINKS IS: 150
****

**** PERIOD IS: 4
****

*** NUMBER OF NEGATIVE POINTS IS: 555
*** NUMBER OF POSITIVE POINTS IS: 501
*** SUM OF HR"S, WHEN DECREASING: 13557
*** NUMBER OF RELATIVE MAXIMA IS: 239
*** NUMBER OF RELATIVE MINIMA IS: 239
*** NUMBER OF BEATS IS : 1056
*** SCORE IS : 2.83619
*** NUMBER OF BLINKS IS: 100
****

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********    FILE NAME IS: **  NIV04.DAT  **********
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**** PERIOD IS:  1
********************

*** NUMBER OF NEGATIVE POINTS IS:        360
*** NUMBER OF POSITIVE POINTS IS:        329
*** SUM OF HR"S, WHEN DECREASING:       7492
*** NUMBER OF RELATIVE MAXIMA IS:        175
*** NUMBER OF RELATIVE MINIMA IS:        175
*** NUMBER OF BEATS IS :                 689
*** SCORE IS :                        2.14057
*** NUMBER OF BLINKS IS:                 142
**************************************************

**** PERIOD IS:  2
********************

*** NUMBER OF NEGATIVE POINTS IS:        397
*** NUMBER OF POSITIVE POINTS IS:        343
*** SUM OF HR"S, WHEN DECREASING:       8604
*** NUMBER OF RELATIVE MAXIMA IS:        187
*** NUMBER OF RELATIVE MINIMA IS:        187
*** NUMBER OF BEATS IS :                 740
*** SCORE IS :                        2.30053
*** NUMBER OF BLINKS IS:                 108
**************************************************

**** PERIOD IS:  3
********************

*** NUMBER OF NEGATIVE POINTS IS:        362
*** NUMBER OF POSITIVE POINTS IS:        312
*** SUM OF HR"S, WHEN DECREASING:       7625
*** NUMBER OF RELATIVE MAXIMA IS:        172
*** NUMBER OF RELATIVE MINIMA IS:        172
*** NUMBER OF BEATS IS :                 674
*** SCORE IS :                        2.21657
*** NUMBER OF BLINKS IS:                 129
**************************************************

**** PERIOD IS:  4
********************

*** NUMBER OF NEGATIVE POINTS IS:        355
*** NUMBER OF POSITIVE POINTS IS:        339
*** SUM OF HR"S, WHEN DECREASING:       8382
*** NUMBER OF RELATIVE MAXIMA IS:        168
*** NUMBER OF RELATIVE MINIMA IS:        169
*** NUMBER OF BEATS IS :                 694
*** SCORE IS :                        2.48724
*** NUMBER OF BLINKS IS:                 146
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APPENDIX-D.3

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT KAO DATE

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	34.9	35.0	38.2	36.5
2	37.2	33.6	36.4	35.3
3	36.4	34.2	37.0	37.1
4	34.8	32.8	38.7	39.1
5	38.5	33.9	37.3	34.8
6	39.5	31.6	36.1	35.8

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT FZP DATE _____

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	38.3	35.9	37.2	35.2
2	36.0	36.4	37.0	36.0
3	36.2	37.5	36.7	35.6
4	37.2	35.7	35.5	36.3
5	36.4	35.9	37.1	35.4
6	36.2	34.3	36.4	37.2

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT FJL DATE

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	35.7	34.4	35.9	35.3
2	35.2	34.2	35.6	33.7
3	34.9	33.4	34.8	33.5
4	34.4	33.2	34.0	33.7
5	32.5	34.3	33.5	33.3
6	33.4	32.7	32.9	33.1

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT ANS DATE

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	34.2	33.3	33.4	33.3
2	32.2	32.4	31.6	33.3
3	31.2	31.7	31.8	31.5
4	31.6	32.4	29.9	34.1
5	32.0	32.1	30.7	33.0
6	32.1	31.7	31.0	30.1

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT NIV DATE _____

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	41.8	40.2	41.3	40.0
2	41.9	38.9	42.6	40.5
3	42.4	35.9	44.7	41.0
4	42.1	37.7	41.7	37.7
5	39.8	36.8	41.1	36.8
6	39.2	37.1	41.5	36.3

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT TKJ DATE

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	38.1	36.4	38.2	38.3
2	36.1	34.1	37.6	35.1
3	34.8	32.6	36.1	34.7
4	34.4	32.1	37.5	32.5
5	33.1	32.4	36.4	33.5
6	32.6	33.2	37.3	33.7

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT GMS DATE _____

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	38.4	33.9	38.8	36.1
2	38.4	35.5	39.6	35.7
3	38.1	34.9	40.1	35.2
4	36.9	34.4	39.5	37.1
5	36.3	35.1	39.9	36.2
6	35.9	34.2	38.5	36.4

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT DEU DATE

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	34.6	34.0	38.1	39.7
2	34.6	34.3	36.8	34.7
3	35.0	33.9	35.6	36.2
4	33.5	32.8	36.8	34.8
5	33.1	32.3	36.5	36.8
6	33.3	31.2	34.0	36.3

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT JSS DATE _____

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	35.1	35.1	34.2	33.9
2	35.8	34.9	31.9	33.6
3	35.9	34.7	31.0	33.1
4	34.5	34.6	31.4	32.6
5	34.5	36.1	32.0	31.0
6	33.7	33.9	32.5	31.7

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

****
** CRITICAL FUSION FREQUENCY **
****

SUBJECT JPD DATE _____

TRIAL #	DISPLAY #1		DISPLAY #2	
	BEF.	AFT.	BEF.	AFT.
1	38.4	35.8	38.5	34.9
2	35.5	34.8	34.7	34.2
3	34.5	33.4	35.4	33.7
4	33.4	33.0	34.9	33.2
5	34.5	32.4	34.8	34.7
6	32.7	33.6	33.4	33.6

KEY:

DISPLAY #1: Negative polarity.
DISPLAY #2: Positive polarity.

VITA AUCTORIS

1957	Born in Tehran, Iran.
1975	Completed Secondary School at Álborz High School, Tehran, Iran.
1980	Received Bachelor of Applied Science (B.A.Sc.) Degree in Electrical Engineering from University of Windsor, Windsor, Ontario.
1983	Currently a Candidate for the Degree of M.A.Sc. in Industrial Engineering.